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DISCRIMINATION BETWEEN EARTHQUAKES AND CHEMICAL
EXPLOSIONS IN EASTERN RUSSIA USING AMPLITUDE RATIOS
OBTAINED FROM ANALOG RECORDS

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Lepolt Linkimer

has been accepted towards fulfillment
of the requirements for the

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Kazuya Fujita
Major Professor's Signature

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DISCRIMINATION BETWEEN EARTHQUAKES AND CHEMICAL EXPLOSIONS IN EASTERN RUSSIA USING AMPLITUDE RATIOS OBTAINED FROM ANALOG RECORDS

By

Lepolt Linkimer

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ABSTRACT

DISCRIMINATION BETWEEN EARTHQUAKES AND CHEMICAL EXPLOSIONS IN EASTERN RUSSIA USING AMPLITUDE RATIOS OBTAINED FROM ANALOG RECORDS

By

Lepolt Linkimer

Amplitudes information from 237 earthquakes ($1.5<m_b<4.9$, $10<\Delta<916$ km) and 247 explosions ($1.4<m_b<3.9$, $6<\Delta<752$ km) recorded by short period analog seismometers in Eastern Russia were used to calculate 1164 amplitude phase ratios of five different types: Pg(h)/Sg(h), Pg(z)/Sg(z), Pg(h)/Sg(z), Pg(z)/Sg(h), and full vector. These amplitude ratios were analyzed in two regions of the Yakutia and Magadan regions of Eastern Russia as earthquake-explosion discriminants in four different ways: the raw phase ratio, the distance-corrected phase (DCP) ratio, the network-averaged phase (NAP) ratio, and the network-averaged distance-corrected phase (NADCP) ratio.

There is a tendency of chemical explosions to have higher values than earthquakes for all types of amplitude ratios studied. The best earthquake-explosion discriminants found for both regions were Pg(h)/Sg(h), Pg(z)/Sg(h), and full vector NAP and NADCP ratios. These discriminants allow for the classification of 86-92% of the ratios as being either earthquakes or explosions. Distinct separations were also found analyzing stations separately.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Images in this thesis are presented in color

1. INTRODUCTION

Discrimination between earthquakes and chemical explosions is a significant problem facing many regional seismic networks around the world. Both earthquakes and chemical explosions are sources of elastic waves; therefore, both are recorded by seismic networks.

Interest in the field of explosion discrimination grew enormously as a result of the negotiations for and of support of the Partial Test Ban Treaty (PTBT) in 1963, the Non-proliferation Treaty (NPT) in 1968, and the current Comprehensive Test Ban Treaty (CTBT) negotiated in 1993 and adopted in 1996. The possibility of negotiating and verifying the CTBT depends in part on the ability of seismic networks to seismically detect and identify underground nuclear tests and other seismic sources, such as earthquakes.

Currently, interest in event discrimination is also associated with the identification and search for active seismic sources in areas where both earthquakes and explosions are recorded by seismic networks. If explosions are not removed from the seismic catalogs of these areas, there is an "explosion contamination" that can result in a misinterpretation of the regional tectonics, and an erroneous assessment of the natural seismic hazard. This "explosion contamination" is the particular aspect that motivated the present study.

Both earthquakes and chemical explosions occur in all regions of Eastern Russia. Earthquakes are concentrated in broad (~ 400-600 km wide) areas associated to the boundaries between tectonic plates in the region, e. g., the Eurasian, North American, Okhotsk, and Amur plates (Figs. 1, 2). On the other hand, chemical explosions are related to mining and the construction of roads, railroads, and dams, many of which occur in the same general area as the natural earthquakes.

The Magadan and Yakutia seismic networks have been recording and locating seismic activity for over 40 years. Although locations of both earthquakes and explosions are contained in published and unpublished Russian regional network bulletins such as those produced by the Yakutia and Magadan regional networks, very few explosions are explicitly marked in the bulletins. Previous studies based on temporal and geographical distribution of earthquakes and explosions have shown that there is considerable contamination by chemical explosions in the earthquake catalogs for these regions (Godzikovskaya, 1995; Odinets, 1996; Mackey and Fujita; 1999; Mackey et al., 2003). As mine blasting occurs mostly during daytime hours, calculating the fraction of day vs. night events in discrete cells has allowed for the identification of geographic regions where the catalog is likely to be contaminated (Fig. 3). However, it is impossible to discriminate between types of individual events using this method, and there have been no other attempts for discrimination using alternate techniques obtained from pre-digital records for these areas.

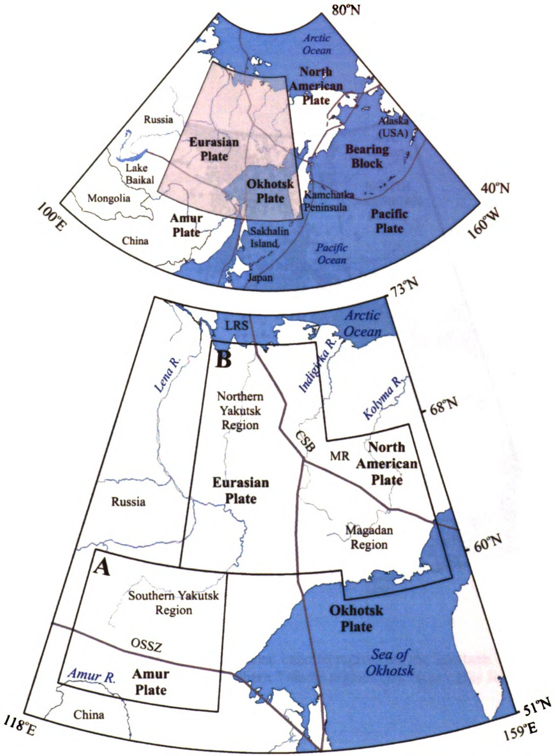

Figure 1. (Top) Regional plate tectonic map of northeast Russia and location of the study area. Heavy gray lines denote plate boundaries. (Bottom) Enlargement of the shaded area. Labeled regions are the Southern Yakutia region (A), and the Magadan and Northern Yakutia regions (B). Other tectonic features are the Chersky Seismic Belt (CSB), the Laptev Rift System (LRS), the Moma Rift (MR), and the Olekma-Stanovoi Seismic Zone (OSSZ).

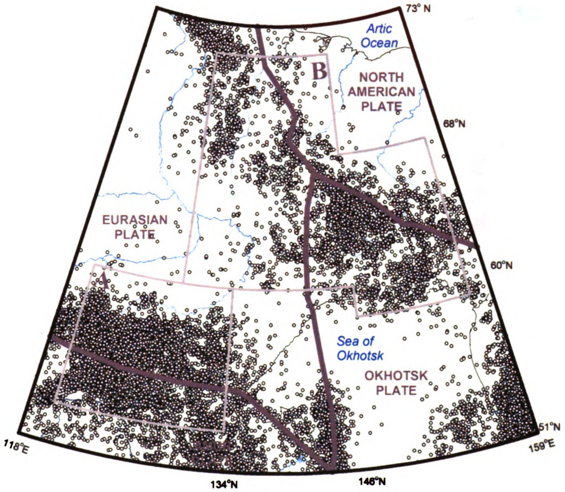

Figure 2. Seismicity map of the study area. Labeled regions are the Southern Yakutia region (A) and the Magadan and Northern Yakutia regions (B). Heavy gray lines denote plate boundaries.

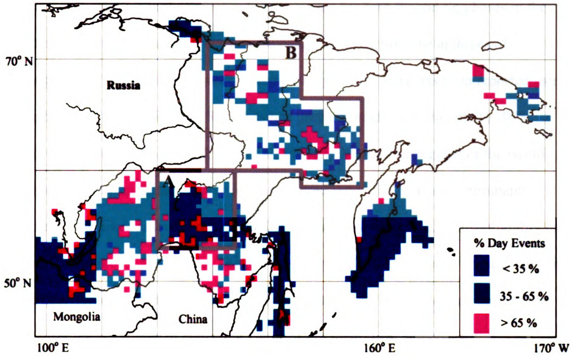

Figure 3. Percentage of seismicity occurring during local daytime in Northeast Russia (Modified from Mackey and Fujita, 2005). Labeled regions are the Southern Yakutia region (A) and the Magadan and Northern Yakutia regions (B).

In this study various types of Pg/Sg amplitude phase ratios are explored as discrimants between earthquakes and explosions for the Yakutia and Magadan regions of Eastern Russia. There is a simple intuitive basis for choosing ratios of P- to S-wave as an earthquake-explosion discriminant. Explosions may be thought of, in theory, as spherically symmetric pressure sources and are expected to generate primarily P waves. On the other hand, earthquakes occur by shear slip along fault surfaces and radiate the greater fraction of their seismic energy as S waves. Therefore, explosions would be expected to have higher Pg/Sg ratios than earthquakes.

Besides the intuitive basis of the Pg/Sg amplitude phase ratio, several other factors motivated its selection as the discriminant to be tested for Eastern Russia. First, there is a sufficient amount of amplitude information for both Pg and Sg phases in the Russian seismic bulletins and it can also be easily obtained from the archives of seismograms in the Russian networks. Second, no previous work has been reported using the Pg/Sg phase ratio in Eastern Russia. Since previous studies (Walter et al., 1995; Taylor, 1996; Hartse et al., 1997; Kim et al. 1997, 1998) in other regions of the world have shown that amplitude phase ratios can be used successfully as a discriminant between earthquakes and both nuclear and chemical explosions, their transportability to Eastern Russia seems reasonable. Third, Pg/Sg amplitude ratios are easy to calculate, and the comparison of these ratios between seismic stations can be easily done because the ratios offer the advantage of canceling variations in instrument responses.

1.1. Geographic Location

The study area is located in the northern part of the Far East of the Russian Federation (Fig. 1). It mostly includes parts of the Sakha Republic (Yakutia) and the Magadan Oblast. It also includes the northern parts of the Amur Oblast and Khabarovsk Krai [1].

Explosion and earthquake identification analysis was performed in regions labeled as A and B in Figure 1. The total size of the two regions under analysis is approximately 4,700,000 km^2, which is about half the size of the United States. Region A comprises part of the Southern Yakutia and adjacent areas to the south, and region B consists of the Magadan District and the northeastern part of Yakutia. These regions were

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[1] Oblast and Krai are terms that describe administrative divisions in Russia

defined based on the location of the earthquakes and explosions found in the bulletins. Since both regions have different neotectonic regimens and crustal structure, the analysis was performed in these two separate regions in order to find possible differences in the performance of earthquake-explosion discriminants.

1.2. Neotectonic Setting

The present tectonic of Eastern Russia results from the complex interactions between at least six different plates and microplates (Fig. 1). The movement of these plates and blocks may be controlled by the mutual convergence of the North American, Eurasian, Indian, and Pacific plates (Taponnier et al., 1982; Parfenov et al., 1987; Worrall et al., 1996). Microplates, such as Okhotsk, Amur, and Bering, and minor blocks, such as Korea-Khabarovsk, Stanovoy, and Transbaikal, have been proposed as being either extruded or rotating in a context of extrusion tectonics (Riegel et al., 1993; Worrall et al., 1996; Mackey et al., 1997; Fujita et al., 1997; Fujita et al., 2004).

The plate boundaries between Eurasian and Amur, Eurasia and North American, Eurasia and Okhotsk, and North American and Okhotsk plates are located within the study area (Fig 1). The boundary between the Eurasian and Amur plates has been proposed to be the Olekma–Stanovoi Seismic Zone (OSSZ) located along the southern edge of the Siberian platform. The OSSZ is up to 200 km wide and extends for 1,000 km to the east of the Baikal rift as far as the Sea of Okhotsk. This zone includes faults of different geometry that move small blocks (Parfenov et al., 1987; Imaev et al., 1994). Region A comprises a portion of this boundary.

The Eurasia–North America plate boundary is defined from north to south by the Laptev Rift System (LRS) and the Chersky Seismic Belt (CSB). The LRS is expressed by several graben systems and seismicity which is primarily concentrated in clusters and bands that link the Arctic Mid-Ocean Ridge to the active CSB on the continent (Fujita et al., 1990a,b; Drachev, 2000; Koz'min et al., 2004). One or two microplates have been proposed in the Laptev Sea area as an attempt to explain the distribution of the seismicity in this region (Avetisov, 199; Drachev, 2000; Franke et al., 2000). Further south, the CSB is defined by a belt of epicenters that is about 400 km wide and 2000 km long and diffusely splits into two main branches: the northern one represents the Eurasia–Okhotsk plate boundary and the southern one represents the North America-Okhotsk plate boundary (Chapman and Solomon, 1976; Riegel et al., 1993; Imaev et al., 1994; Seno et al., 1996; Fujita et al., 1997). Two aspects make the Eurasia–North America plate boundary very peculiar: the North America–Eurasia pole of rotation is located in the vicinity of the plate boundary (Cook et al., 1986) and the LRS is one of the few places on Earth where an active ocean spreading center enters a continental edge (Drachev, 2000; Franke et al., 2000). Region B incorporates much of the CSB.

The Eurasia–Okhotsk plate boundary is defined by a right lateral transpressional zone that extends from the CSB to Sakhalin Island (Riegel et al., 1993; Imaev et al., 1994, 2000).

The North America-Okhotsk plate boundary is a left-lateral transpressional zone that extends from the CSB to the Kamchatka Peninsula (Riegel et al., 1993; Imaev et al., 1994). This plate boundary is presumed to lie on the Ulakhan fault, which is one of the largest strike-slip fault systems in northeastern Asia (~1500 km long). It has a spectacular expression that can be traced distinctly by remote sensing photographs and topographic maps (Imaev et al., 1994, Fujita et al. 2004).

The Moma Rift (MR) is another structure that is frequently discussed in the tectonic literature of Eastern Russia (Fig. 1). It comprises a series of northwest trending topographic depressions mainly located along the North America-Okhotsk plate boundary between the Indigirka and Kolyma rivers. Even though both high heat flow and isolated recent volcanism are observed along the MR, this structure is considered to be an aborted Pliocene rift system. Based on focal mechanisms and geology, several authors have proposed that today the MR is a transpressional zone along most of its length (Cook et al., 1986; Fujita et al., 1990a; Imaev et al., 1995, Franke et al., 2000).

1.3. Previous Work on Explosion Discrimination

The problem of explosion and earthquake discrimination has long been known in seismology. Given this interest in the CTBT, nuclear explosions have been the focal point for the studies of explosions as seismic sources and their comparisons with earthquakes. Nevertheless, other events of significance, such as chemical explosions (mining, constructions), rock bursts, mine collapses, and volcanic earthquakes are also found in the literature.

The key to discriminating between earthquakes and explosions is an examination of the sources of each event. Among the factors that are likely to differentiate earthquakes from explosions in seismograms are the source mechanisms, i.e., double couple for earthquakes vs. center of dilation for explosions, the amount of shear and compressional energy that is radiated from the source, the duration of the processes at the source, and the depth of the source. Table 1 contains a summary of the theoretical differences between earthquakes and explosions discussed in this section.

Most previous studies on earthquake-explosion discrimination have mainly involved the analysis of wave forms (amplitudes, frequencies, energy) and the temporal and geographical distribution of earthquakes and explosions. Amplitude ratios from combinations of seismic phases and frequency bands have been used successfully to discriminate between earthquakes and both chemical and nuclear explosions. However, only approaches based on geographical and temporal distribution of earthquakes and explosions are found in the literature for the study area in Eastern Russia (Tables 2 and 3).

Explosions and earthquakes differ fundamentally in their source function. In general, the source time function of earthquakes shows a complex source process with a longer duration, implying that earthquake processes involve a fault dimension of a few to several tens of kilometers. In contrast, the explosion source presents a relatively simple source time function with one or two pulses and a much shorter source duration (Li et al., 1995).

In theory explosions are "expansion center" sources, therefore, the primary waves they emit are recorded at all azimuths as compressional waves. This is true for nuclear explosions and also for explosion fields used in open-pit mining and construction (Deneva et al., 1989). As opposed to explosions, earthquakes are recorded with a quadrant or quasi-quadrant P-wave polarity distribution. Unfortunately, first motions observations not always can be read because amplitudes are very low.

Table 1. Theoretical differences between earthquakes and explosions of similar magnitude. See text for references.

Factors	Explosions	Earthquakes
First motion of P wave	Compression at all azimuths[(1)]	Quadrant or quasi-quadrant sing distribution (compression and dilation depending on the azimuth)
Complexity of the source rupture process	Simpler, it comprises one or two simple pulses [(2)]	More complex, it comprises multiple source pulses
Duration of processes at the source	Shorter [(2)]	Longer
Source dimension	Smaller	Much larger
Presence of surface waves at regional distances	High-amplitude	Almost unobservable
Frequency of the dominant amplitude	Above 10 Hz	Below 10 Hz
Source depth	Usually no more than tens to hundreds of meters	Usually deeper than 2.5 km
Attenuation with distance	Faster	Slower
Macroseismic surface effect	Felt at smaller distances	Felt more strongly and at greater distances
Origin local time	Show time periodicity, usually diurnal	Do not show time periodicity

1. However, tectonic release caused by an explosion can generate a non-isotropic radiation pattern like a double couple earthquake (Fujita et al., 1995; Li et al., 1995).

2. However ripple fire explosions can be complex sources with duration of several seconds.

Table 2. Selected previous works on discrimination between chemical explosions and earthquakes

Reference	Discriminant	Region
Agnew (1990)	Analysis of the temporal and geographical distribution of the seismicity using histograms and maps	San Diego area, southern California
Deneva et al. (1989)	Amplitude phase ratios (S/P) and envelopes of coda waves	Sofia seismic zone, Bulgaria
Fäh and Koch (2002)	Multivariate statistical analysis considering S/P ratios	Central Switzerland
Filina (1999)	Ratios of periods (S/P)	Altai-Sayan Region (southern Siberia and parts of Kazakhstan, China, and Mongolia)
Fujita et al. (2002)	Analysis of the temporal and geographical distribution of the seismicity	Chukotka, Northeastern Russia
Kim et al. (1997)	3-D spectrograms and Pg/Lg ratios	Southern Russia, near Kislovodsk
Kim et al. (1998)	3-D spectrograms and Pg/Lg at different frequency bands	North and South Korea
Kim et al. (1993)	Pg/Lg ratios	Northeastern United States
Mackey, (1999); Mackey and Fujita, (1999 and 2001); Mackey et al. (2002), and Mackey et al. (2003)	Analysis of the temporal distribution of the seismicity using maps showing the percentage of seismicity occurring during local daytime in discrete cells	Eastern Russia
Malamud and Nikolaevskii (2001)	ΔK (K class comparison at different distances)	Dushanbe-Vakhsh region, Tajikistan
Odinets (1996)	Analysis of the temporal distribution of the seismicity using histograms	Kolyma Region, northeastern Siberia.
Wiemar and Baer (2000)	Ratios of daytime to nighttime events in discrete cells	Switzerland, Alaska, and Western US

Table 3. Selected previous works on discrimination between nuclear explosions and earthquakes

Reference	Discriminant	Region
Derr (1970)	Rayleigh-wave spectral amplitude ratios	Western United States
Hartse et al. (1997)	Many combinations of amplitude ratios at different frequency bands	Western China and Kyrgyzstan
Li et al. (1995)	Relative source time functions estimated using empirical Green's functions	Central Asia (southern Siberia and nonwestern China)
Pomeroy et al. (1982)	Fifteen classes of regional discriminants, including first motion, Ms:m_b, and Lg/Rg, Pn/Lg, Pg/Lg and P_{max}/Lg amplitude ratios	Global
Stevens and Day (1985)	m_b: Ms and Variable Frequency Magnitude (VFM)	Global
Taylor et al. (1989)	Multivariate statistical analysis considering m_b: Ms, Lg/Pg, Lg/Rg, Lg/Sm short period amplitude ratios, and Pn,Pg, and Lg spectral ratios	NTS and Western United States
Taylor (1996)	Pg/Lg, Pn/Lg, and Lg and Pg spectral ratios	NTS and Western United States
Walter et al. (1995)	Pn/Lg and Pg/Lg and Pn, Pg, Lg and Lg coda spectral ratios	NTS

NTS. Nevada Test Site

The reliability of the first motion as an earthquake-explosion discriminant can be also affected by the distorting influence of instruments and local structure that change the authentic pattern of the first motions (Pomeroy et al., 1982; Filina, 1999). It is also important to recognize that tectonic release caused by larger explosions could generate a non-isotropic radiation pattern like a double couple earthquake (Li et al., 1995). For example, the "Horizon-4" peaceful nuclear explosion detonated in the Northern Yakutia region in 1975 presents a mechanism of a double-couple thrust source (Fujita et al., 1995).

Another fundamental difference between earthquakes and explosions is the depth of the source. Explosions usually have depths of tens to hundreds of meters, whereas earthquakes are usually deeper than 2.5 km. However, this fact cannot always be used as a criterion of discrimination, since the accuracy of hypocenter determinations in a regional network is about 2.5 km at best (Malamud and Nikolaevskii, 2001).

Since the majority of explosions occur at shallower depths than earthquakes, there is a predominant effect of depth on seismic waves. One difference observed in records obtained at equal regional distances from explosions and earthquakes that have comparable energy is the presence of high-amplitude surface waves in explosions records. On the other hand, surface waves from earthquakes at similar distances are almost unnoticeable against the background of S waves. This makes the shape of the envelope a criterion of explosion recognition because it essentially reflects the presence of more intense surface waves in explosions (Filina, 1999).

The frequency content is also different between explosions and earthquakes. Several studies have suggested that the frequency of the dominant amplitude appears to be higher (above 10 Hz) for explosions than for earthquakes (Kim et al., 1997; Kim et al., 1998). It is important to note that the frequency contents of P and S waves depend on the specific propagation paths and local structure; therefore, the frequency of the dominant amplitude may vary from one region to another.

The duration of processes at the source has also been found to be different between the two types of events. For example, moderate earthquakes ($5.5<m_b<6.6$) have a duration of several tens of seconds in contrast to nuclear explosions of similar magnitude that take about 0.4 to 1.6 s (Davies and Smith, 1968; Li et al., 1995).

The shorter duration at the source and the usually shallower depths for explosions and the greater absorption of higher frequency components during the travel of seismic waves result in a faster attenuation with distance of a seismic waves emitted by explosions. This can be noticed in the different macroseismic surface effects for the two types of events. Weak earthquakes in mining regions are felt more strongly and at greater distances than explosions with similar magnitudes (Deneva, et al. 1989; Filina, 1999).

1.3.1. Discrimination Based on Amplitude Ratios of Seismic Phases

This methodology is based on the observation that the maximum amplitude and frequency content for both body and surface waves from earthquakes and explosions are different. Considering this fact, amplitude ratios are made from many combinations of seismic phases and frequency bands and then are evaluated as seismic discriminants.

Amplitude ratios and spectral analysis of seismic phases have been used successfully to separate earthquakes from both chemical (i.e. Deneva et al., 1989; Walter et al., 1995; Filina, 1999; Kim et al., 1993, 1997, 1998, and Fäh and Koch, 2002, among others) and nuclear (i.e. Derr, 1970; Walter et al., 1995; Taylor et al., 1989; Taylor, 1996, and Hartse et al., 1997) explosions. Figure 4 shows two examples amplitude ratios obtained from these studies.

One aspect of explosion and earthquake discrimination based on amplitude ratios and spectral analysis of seismic phases is that the performance of the same discrimant as well as the mean value of the amplitude ratio varies from one region to another. This is due to the dependence of the frequency content of P and S waves on specific propagation paths, local structure, and regional variation in geology, tectonic, and topographic structure (Kim et al., 1993; 1997; Walter, et al., 1995; Rodgers et al., 1997). For example, Derr (1970) showed that the short-to-long period Rayleigh-wave spectral amplitude ratio discriminated earthquakes and nuclear explosions in the western United States, but it did not work for the Aleutian Islands. Another example was presented by Kim et al. (1997) in southern Russia, near Kislovodsk, where the mean vertical component Pg/Lg (5-20 Hz) was found to be 1.3 for earthquakes and 3.2 for chemical explosions. These values are much higher than the mean obtained by Kim et al. (1993) in the eastern United States, where the Pg/Lg ratios (5-25 Hz) were 0.5 and 1.25 for earthquakes and chemical explosions, respectively.

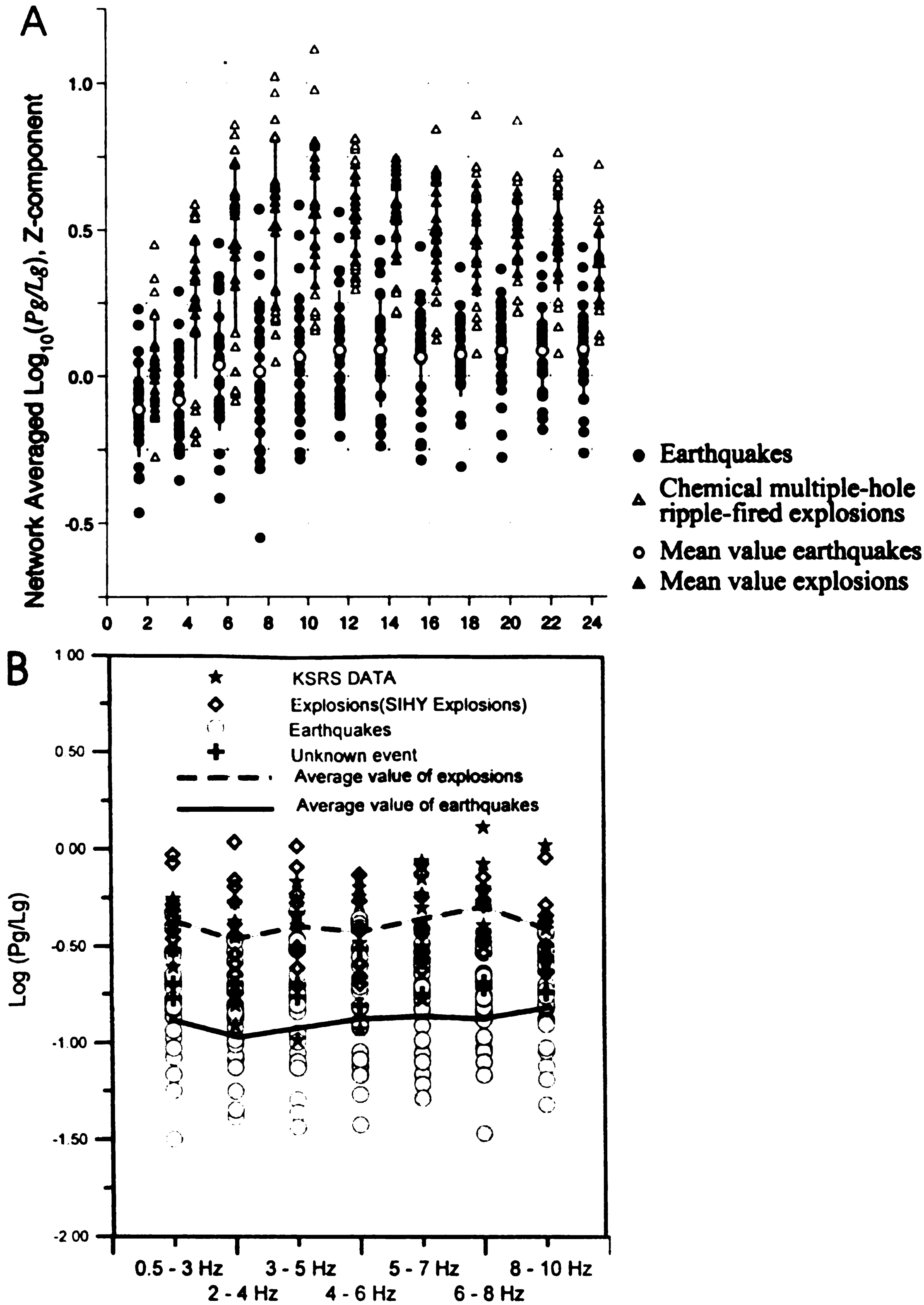


Figure 4. Examples of amplitude phase ratios obtained in previous studies. A) Network-averaged Pg(z)/Lg(z) ratios from the Caucasus area, southern Russia (From Kim et al., 1997). B) Pg(z)/Lg(h) ratios from the Korean Peninsula (From Kim et al., 1998).

The rock properties (gas porosity, density, and velocity) in the near-source zone of explosions have also been found to have an effect on the performance of the same discriminant in different regions. For example, Walter et al. (1995) showed that the Pg/Lg ratio separates all the earthquakes from the Nevada Test Site (NTS) nuclear explosions detonated in low gas-porosity-high strength materials. On the other hand, nuclear explosions detonated in high gas-porosity-low strength materials significantly overlap the earthquakes. Hartse et al. (1997) showed that the Lg (3-6 Hz/0.75-1.5 Hz) spectral ratio did not separate earthquakes and nuclear explosions in central Asia in the same way that these events were separated at the NTS. According to these authors, this situation may be due to source medium properties effects, as Asian explosions are thought to be detonated in highly lithified rocks below the water table, while most of the smaller (m_b<4.8) NTS explosions have been detonated in poorly lithified rocks above the water table.

Below, a brief summary of the results obtained by several authors using amplitude ratios and spectral analysis is presented. Deneva et al. (1989) successfully discriminated between chemical explosions and earthquakes using amplitude (S/P) ratios as a function of both magnitude and distance. They studied the Sofia seismic zone in Bulgaria using 1500 events ($6 < \Delta < 50$ km, 0.5 < Mag.< 2.3), of which 1420 were explosions and 80 were earthquakes, recorded with a vertical short-period seismograph (S-13 seismometer). They concluded that when the S/P amplitude ratio is above 2.5 the source is not an explosion.

Filina (1999) compared the frequency compositions of body and surface waves of 90 chemical explosions and earthquakes ($50 < \Delta < 700$ km, 1.5 < Mag. < 3.5) recorded by SMK-3 instruments in the Altai-Sayan region which includes southern Siberia and adjacent areas of Kazakhstan, China, and Mongolia. The frequency composition was analyzed using visible periods of maximum phases for waves of various types. The ratio of periods (Ts/Tp) from earthquakes and explosions was found to be practically independent of epicentral distances, but it is higher by about 0.3 in the case of explosions.

Kim et al. (1997) observed that earthquakes and chemical multiple-hole ripple-fired explosions in the Caucasus area of southern Russia, near Kislovodsk, show distinctive patterns in the spectral content of P and S waves. They analyzed high frequency (1 to 25 Hz) regional records from 25 small earthquakes (Mag. < 4.5) and chemical explosions of comparable magnitude in distance ranges of 15 to 233 km. They found that the network-averaged vertical component Pg/Lg in the frequency band of 8 to 18 Hz served well for classifying the events, with explosions having higher values than earthquakes (Fig. 4a). They found that the Pg/Lg spectral ratios of rotated, three–component regional records improved the discrimination power of the spectral ratio method in the same frequency band.

A similar approach was used by Kim et al. (1998) to study the frequency content of ten chemical explosions (Mag. ≤ 3.0) and 20 small earthquakes (Mag. ≤ 4.0) recorded in the Korean Peninsula. In order to get closer to the radiation characteristics of the sources, these authors calculated the Pg/Sg ratio from free surface corrected P, SV, and SH seismograms and considered the average of frequency bands obtained for each station. They found that chemical explosions had higher values than earthquakes (Fig. 4b). The best separation was observed from 6 to 8 Hz with a critical value of log(Pg/Sg) = -0.5 (or Pg/Sg = 0.32), although other frequency bands were also valid for discrimination.

Walter et al. (1995) analyzed 130 underground nuclear explosions, one large chemical explosion, and 50 earthquakes ($190 < \Delta < 315$ km; $2.0 <$ Mag. < 6.5) recorded at two broadband seismic stations in the vicinity of the NTS. They found that the Pn/Lg and Pg/Lg phase ratios both showed little dependence on magnitude and worked better at higher frequencies and when the two stations used were averaged. At 6 to 8 Hz explosions have larger Pn/Lg ratios than earthquakes.

Taylor (1996) also studied events at the NTS. This author was able to correctly identify 95% of 294 NTS nuclear explosions and 114 western United States earthquakes ($175 < \Delta < 1300$ km, $2.5 <$ Mag. < 6.5) using the high-frequency (0.5 and 10 Hz) Pg/Lg discriminant in six different frequency bands for events recorded at four broadband seismic stations. The best discrimination occurred for larger magnitudes and higher frequencies (6-8 and 8-10 Hz bands).

Hartse et al. (1997) successfully discriminated between earthquakes and underground nuclear explosions using different types of amplitude ratios. They measured noise and signal levels of over 380 earthquakes ($2.5 > m_b > 6.1$) and 31 underground nuclear explosions ($4.5 > m_b > 6.5$) recorded at different regional distances (<1700 km) at two stations in western China and Kyrgyzstan. They concluded that the most effective discriminants for this region were the following: phase ratios for frequencies above 4 Hz, P(3-6 Hz/0.75-1.5 Hz) spectral ratios, P(3-6 Hz)/S(0.75-1.5 Hz) cross spectral ratios, and short period ($\geq$1 Hz) to long period Rayleigh-wave (0.05-0.1 Hz) ratios. For all of these ratios, explosions had higher values than earthquakes.

1.3.2. Discrimination Based on Geographical and Temporal Distribution

Temporal analysis of the seismicity is a very simple and practical method for detecting areas with explosion contamination. The basis of this method is that blasting, whether or not geographically dispersed, is usually concentrated in time. This is because chemical and mining explosions are usually detonated during the daytime hours. On the other hand, earthquakes do not show such a diurnal periodicity.

A ratio of daytime to nighttime events (Rq) is a useful way to express time-biased seismicity. Wiemar and Baer (2000) identified regions with high quarry activity in Switzerland, Alaska, and the western part of the United States by mapping Rq over the mentioned regions.

Examples of time-biased temporal distribution of the seismicity are usually found in the vicinity of mining regions and construction projects. For example, in Southern Russia, near Kislovodsk, Kim et al. (1997) observed that 87.5% of the events recorded in 1992 and located within 15 km of the Tyrnauz mine were clustered near two peak times, 10 am and 4 pm. They also observed that 100% of the events located within the 10 km radius of the Ust-Djeguta and Tsementny-Zavod quarries, also in southern Russia, were clustered near 2 pm. Another example was discussed by Agnew (1990) in the San Diego area of southern California. This author showed that the seismicity from 1976 to 1988 had two large peaks in time: one just before noon and another in the late afternoon.

1.3.3. Previous Studies in Eastern Russia

Analysis of the temporal distribution of recorded events has also been applied to identify areas of explosion contamination in Eastern Russia (Godzikovskaya, 1995;

Odinets, 1996; Mackey, 1999; Mackey and Fujita, 1999 and 2001; Fujita et al., 2002; Mackey et al., 2002; and Mackey et al., 2003).

Odinets (1996) found that a large fraction of the earthquakes reported in the central Kolyma region in northeast Siberia were in reality explosions. Mackey and Fujita (2001) observed regions with presumed explosion contamination based on the fact that the majority of seismicity occurs during daytime hours. Mackey (1999) found that the Amur District had the clearest explosion contamination. He observed that when he plotted local daytime and local nighttime epicenters separately, there were several large clusters of epicenters that could be correlated geographically with specific mining regions.

Mackey et al. (2003) calculated the fraction of day vs. night events in discrete cells for Eastern Russia (Fig. 3). These authors noted several clusters with more than 90% of events occurring during local daytime. Areas where events occurred primarily during daylight hours were correlated geographically with specific mining regions. They also found a correlation between daytime-biased cells with constructions projects, such as the route of the Baikal-Amur mainline railroad construction and the Kolyma hydroelectric dam in northeast Siberia. They also identified areas with explosion contamination in the Amur District (Fig. 5), Southern and Northern Yakutia regions, the Magadan region, and Sakhalin Island. The Polyarni region in Chukotka was also found to have explosion contamination (Fujita et al., 2002; Mackey et al., 2003).

Mackey and Fujita (2001) and Mackey et al. (2003) determined that, for northeast Siberia, the levels of explosion contamination also changed with the season because explosions in placer mining districts are mostly concentrated during the late winter and early spring, when frozen ground is broken up for the summer processing season.

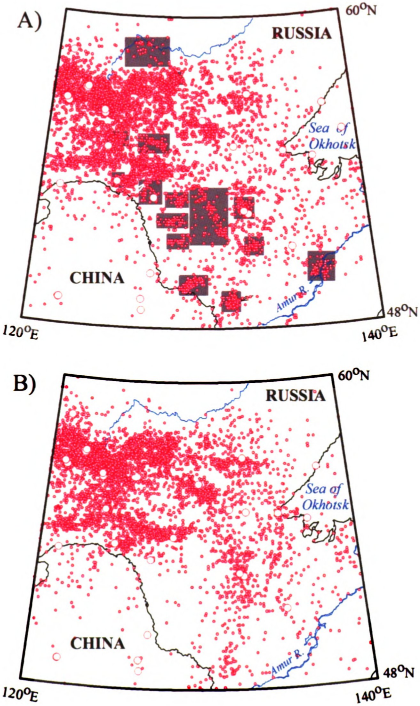


Figure 5. Seismicity in the Amur region. A) Daytime. B) Nighttime. Gray shaded regions indicate clear explosion contamination (Modified from Mackey et al., 2003).

1.3.4. Other Techniques

The m_b:Ms, Variable Frequency Magnitude (VFM), and the ΔK discriminants are other techniques used for earthquake-explosion discrimination that involve the comparison of seismic energy radiated from earthquakes and explosions.

The m_b:Ms discriminant is mostly used for discriminating earthquakes and nuclear explosions. This method is based on the observation that, in general, nuclear explosions have substantially higher m_b than earthquakes for the same seismic moment. This results in a difference between the magnitudes of body and surface waves (m_b-Ms) that is greater for explosions than for earthquakes. (Douglas et al., 1974, Stevens and Day, 1985, Taylor et al., 1989).

The Variable Frequency Magnitude (VFM) method is based on the observation that body waves from nuclear explosions contain more high-frequency energy than body waves from earthquakes of comparable size. In this method, the body wave magnitude is measured from narrow-band-filtered seismograms at two different frequencies, f_1 and f_2, usually about $f_1 = 0.5$ Hz and $f_2 = 3.0$ Hz. In many circumstances, a plot of $m_b(f_1)$ versus $m_b(f_2)$ produces a clear separation of earthquakes and explosions. When spectral magnitudes are measured for a large number of events, the earthquake and explosion populations fall into different regions on the plot, with $m_b(f_2)$-$m_b(f_1)$ typically larger for explosions than for earthquakes (Stevens and Day, 1985).

Malamud and Nikolaevskii (2001) proposed a convenient method based on the comparison of seismic energy (K) class from data of two stations at different epicentral distances in the Dushanbe-Vakhsh region in Tajikistan. They demonstrated that the difference ($\Delta K=K_i-K_j$) between two stations (i and j) at different distances ($x_i < x_j$) is generally positive for earthquakes and negative for chemical explosions. This may be attributed to the fact that most of the seismic energy generated by explosions attenuates in the zone near the source. Consequently, with increasing distance, a further decrease in the amplitude of an explosion-generated signal is much less significant than in the case of earthquake signals. This technique does not allow the discrimination for some pairs of stations. The authors attributed this situation to specific local tectonic effects, such as the anisotropy and fracturing of rocks.

2. DATA ANALYSIS AND RESULTS

In the following sections, the methodology of amplitude phase ratio processing are explained. Amplitude phase ratios are shown in four different ways: the raw phase ratio, the distance-corrected phase (DCP) ratio, the network-averaged phase (NAP) ratio, and the network-averaged distance-corrected phase (NADCP) ratio. The results are discussed separately for the two regions studied: the Southern Yakutia region and the Magadan and Northern Yakutia regions.

2.1. Data Sources, Seismic Stations, and Type of Explosions

Amplitude information, arrival times, and location parameters of 544 events, including 259 earthquakes and 285 known chemical explosions, recorded between 1985 and 2000, were acquired from unpublished bulletins and analog seismograms made available from the Yakutia and Magadan regional networks.

The amplitude collected from the bulletins consists of peak-to-peak maximum amplitudes for both Pg and Sg phases recorded on each of the three components Z, N-S, and E-W. Amplitudes were determined from analog seismograms in Russia by measuring the maximum peak of both Pg and Sg phases in millimeters. In order to obtain amplitude in microns, these values were first divided by two, and then divided by the station amplification in thousands. Two examples of amplitude measurements made using seismograms from an earthquake and an explosion obtained in Russia are shown in Figure 6.

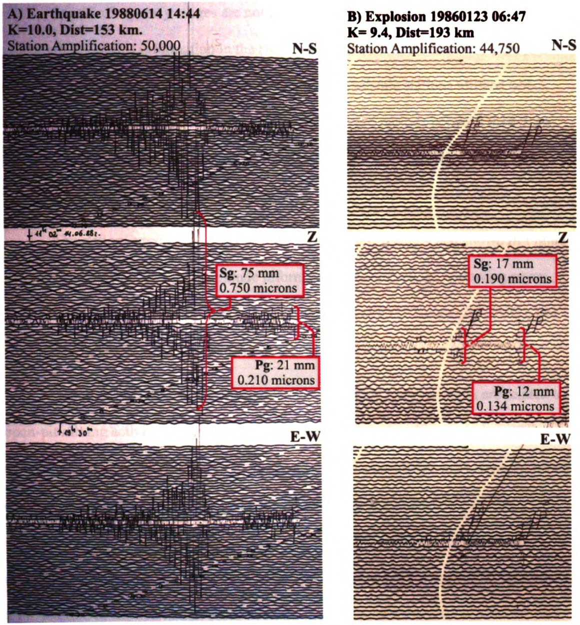


Figure 6. Examples of amplitude measurements made on the vertical component of a seismogram of A) An earthquake recorded at SEY and B) an explosion recorded at USZ. The amplitude calculation is shown for both Pg and Sg phases. Note that these seismograms read from right to left.

Specific frequency ranges are not considered explicitly in this study due to the unavailability of this information in the analog Russian bulletins. However, there is a frequency range implicit in the records used, since the seismic stations utilized SM-3, SKM, or VEGIK short period seismometers, which record periods between 0.18-1.3 s (0.76-5.5 Hz). This is considered the frequency range in which the phase ratios calculated in this study are valid.

The stations used in the analysis are summarized in Table 4 and shown in Figure 7. Approximately 65% of the amplitude information comes from the following seven stations: Chagda (CGD), Chul' man (CLNS), Seimchan (SEY), Tungurcha (TUG), Ust' Nera (UN1S), Ust' Nyukzha (USZ), and Ust' Urkima (UURS).

The majority of the chemical explosions considered in the analysis are related to open-pit mining activities. These explosions were conducted under a technique called ripple fire. The geometry of the detonation consisted of a set of five to 15 lines, in which each line has a number of holes filled with explosives to depths of 10-15 m. The detonation occurs with a time delay in each line that can be in the order of 50 milliseconds. The total amount of explosive used could range from 10 to 200 tons and the total duration of the detonation could be in the order of tends of seconds (Mackey, pers. comm.)

Table 4. Seismic stations used in this study

Station	Name	Lat N	Long E	Seismic Network	Number of ratios	Region[1]
ATKR	Artyk	64.18	145.13	Yakutia	24	B
BTG	Batagai	67.65	134.63	Yakutia	9	B
CGD	Chagda	58.75	130.62	Yakutia	77	A,B
CLNS	Chul' man	56.84	124.89	Yakutia	64	A
DBI	Debin	62.34	150.75	Magadan	24	B
EVES	Evensk	61.92	159.23	Magadan	1	B
KHG	Khandiga	62.65	135.56	Yakutia	9	A
KROS	Kirovskii	54.43	126.97	Amur	22	A
KU-	Kulu	61.89	147.43	Magadan	1	B
MGD	Magadan	59.56	150.81	Magadan	2	B
MOMR	Moma	66.47	143.22	Yakutia	20	B
MYA	Miyakit	61.41	152.09	Magadan	7	B
NAY	Naiba	70.85	130.73	Yakutia	7	B
NKBS	Nel'koba	61.34	148.81	Magadan	26	B
NZDS	Nezhdanisk	62.50	139.06	Yakutia	18	A
OMS	Omsukchan	62.52	155.77	Magadan	3	B
SAY	Saidy	68.70	134.45	Yakutia	7	B
SEY	Seymchan	62.93	152.38	Magadan	40	B
SNES	Sinegor'e	62.09	150.52	Magadan	13	B
SSY	Sasyr'	65.16	147.08	Yakutia	25	B
SUUS	Susuman	62.78	148.16	Magadan	37	B
TBK	Tabalakh	67.54	136.52	Yakutia	13	B
TLI	Tenkeli	70.18	140.78	Yakutia	4	B
TLAR	Talaya	61.13	152.39	Magadan	9	B
TNL	Tonnel'nyi	56.29	113.35	Irkutsk	1	A
TTY	Takhtoyamsk	60.20	154.68	Magadan	3	B
TUG	Tungurcha	57.28	121.50	Yakutia	79	A
UL2S	Kamenistyi	65.41	144.83	Yakutia	2	B
UN1S	Ust' Nera	64.57	143.23	Yakutia	79	B
USZ	Ust' Nyukzha	56.56	121.59	Yakutia	133	A
UURS	Ust' Urkima	55.30	123.22	Yakutia	85	A
YAK	Yakutia	62.03	129.68	Yakutia	6	A
YUB	Yubileniya	70.74	136.09	Yakutia	3	B
ZYR	Zyryanka	65.72	149.82	Yakutia	5	B

1. The seismic station recorded events located in regions A and B denoted in Figure 1: the Southern Yakutia region (A) and the Magadan and Northern Yakutia regions (B).

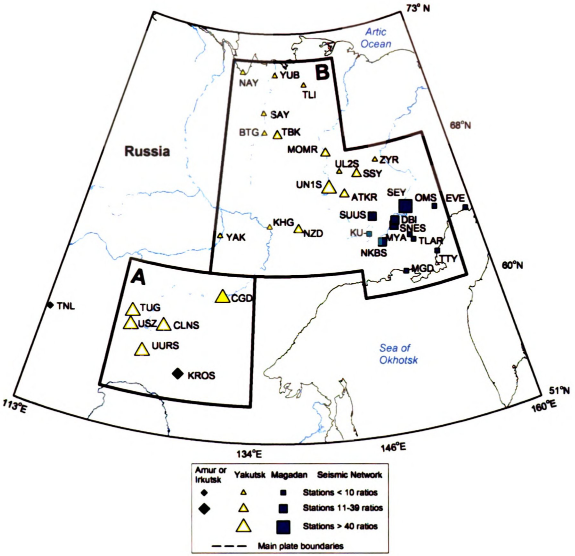


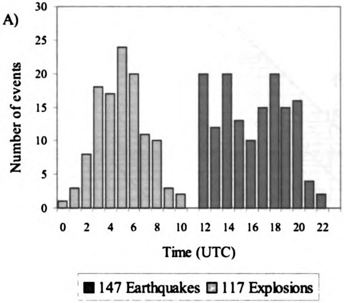
Figure 7. Seismic stations used in this study. Labeled regions are the Southern Yakutia region (A) and the Magadan and Northern Yakutia regions (B). See Table 4 for more details. Size of symbols denotes amount of data available.

2.2. Phase Ratio Processing and Methodology

The 544 events collected initially were separated into two groups: night-time earthquakes and day-time known explosions. The time window selected for the earthquake group was 11:00-22:59 UTC for the Southern Yakutia region and 9:00-20:59

UTC for the Magadan and Northern Yakutia regions. The time window for the explosion group was 23:00-10:59 UTC for the Southern Yakutia region and 21:00-8:59 UTC for the Magadan and Northern Yakutia regions (Fig. 8). This separation was done because night time seismicity better reflects tectonic trends as most explosions are excluded (Mackey and Fujita, 2001; Mackey et al., 2003, Fig. 3). Only daytime events clearly identified in the bulletins as "explosions" are included in the database for the explosion group.

Events with Pg and Sg phase amplitude information in all three components (Z, N-S, and E-W) for at least one station were selected. Events with amplitude information for Pg in Z and Sg in both N-S and E-W components were also selected. This selection was conducted because values of K class could always able to be calculated using the nomogram of Rautian (1960) that requires at least amplitudes of the Z component for Pg and the horizontal components for Sg (Fig. 9). One advantage of records with amplitudes in all components is that it allows for the calculation and comparison of any possible combination of amplitude phase ratios as well as the full vector. This permitted the comparison of the performance of amplitude phase ratios using the exact same set of data.



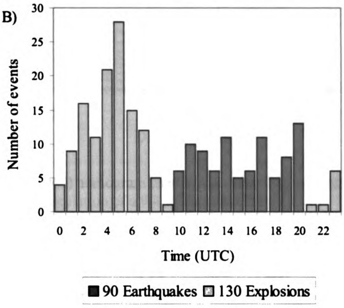


Figure 8. Distribution by time of the events used. A) The Southern Yakutia region. B) The Magadan and Northern Yakutia regions.

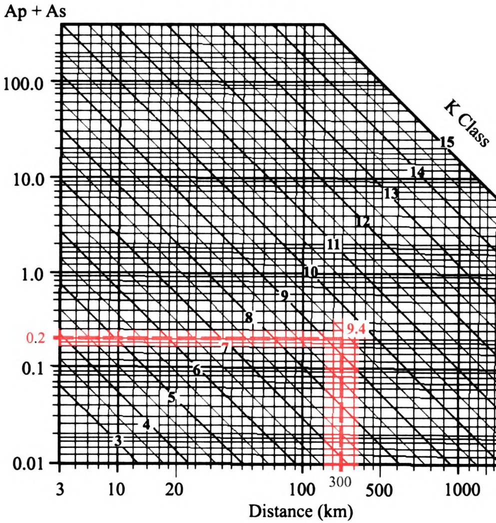


Figure 9. The Rautian (1960) nomogram used to calculate K class. Dashed red lines denote an example of a calculation of a 9.4 value of K Class.

From the amplitude information, the following five types of phase ratios were created:

1. $$\frac{Pg(h)}{Sg(h)} = \frac{\sqrt{(Pg_{NS})^2 + (Pg_{EW})^2}}{\sqrt{(Sg_{NS})^2 + (Sg_{EW})^2}}$$

2. $$\frac{Pg(z)}{Sg(z)} = \frac{Pg_Z}{Sg_Z}$$

3. $$\frac{Pg(h)}{Sg(z)} = \frac{\sqrt{(Pg_{NS})^2 + (Pg_{EW})^2}}{(Sg_Z)}$$

4. $$\frac{Pg(z)}{Sg(h)} = \frac{Pg_Z}{\sqrt{(Sg_{NS})^2 + (Sg_{EW})^2}}$$

5. $$\text{Full Vector} = \frac{\sqrt{(Pg_Z)^2 + (Pg_{NS})^2 + (Pg_{EW})^2}}{\sqrt{(Sg_Z)^2 + (Sg_{NS})^2 + (Sg_{EW})^2}}$$

The five types of amplitude phase ratios were plotted against the energy class of the seismic shock (K) as calculated by each station.

The database of selected events consisted of 484 events (Fig. 10). These events are distributed in the two studied regions as follows: 147 earthquakes in the Southern Yakutia region and 90 earthquakes ($6.1 < K < 12.8$, $16 < \Delta < 916$ km) and 130 explosions ($4.8 < K < 10.2$, $9 < \Delta < 752$ km) in the Magadan and Northern Yakutia regions. From the amplitudes of these 484 events, 1164 Pg(z)/Sg(h) and 858 of the other four types of phase ratios were calculated. Table 5 summarizes the number of events and ratios per region and other parameters of the selected events. Appendix A shows the amplitudes collected for these events.

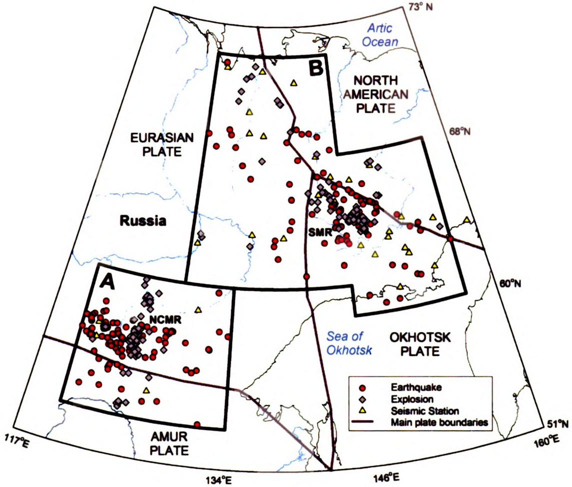


Figure 10. Location map of events used. Labeled regions are the Southern Yakutia region (A), the Magadan and Northern Yakutia regions (B), the Neryungri-Chulman mining region (NCMR), and Susuman miming region (SMR).

Table 5. Characteristics of the database of selected events

	Southern Yakutia		Magadan and Northern Yakutia	
	Earthquakes	**Explosions**	**Earthquakes**	**Explosions**
Number of events	147	117	90	130
Number of Pg(z)/Sg(h)	323	251	370	220
Number of ratios (other four types)	259	206	255	138
Distance range	10-900 km	6-423 km	16-916 km	9-752 km
K class range	5.2-12.6	4.8-10.6	6.1-12.8	4.8-10.2
m_b range [1]	1.5-4.8	1.4-3.9	1.9-4.9	1.4-3.7
UTC time window	11:00-22:59	23:00-10:59	9:00-20:59	21:00-8:59

1. Magnitude (m_b) was calculated using the regional regression of $m_b = 5.4+0.44$ (K-14).

2.2.1. The Distance Correction

In order to improve the separation between explosions and earthquakes and account for attenuation effects, a distance correction was applied to the five types of phase ratios previously calculated. Figure 11 shows an example of the procedure followed to calculate distance corrected phase ratios. The phase ratios of one explosion and one earthquake of the same size (K class 8) are highlighted in order to illustrate more clearly the effects of the correction. The distance correction was calculated using a linear regression for the earthquake data in an amplitude-phase-ratio vs. epicentral-distance graph. In this example, the linear regression is given by a slope of -0.0001 and a y-intercept of 0.2326 (Fig 11a). The coefficient of determination (R^2) was also calculated.

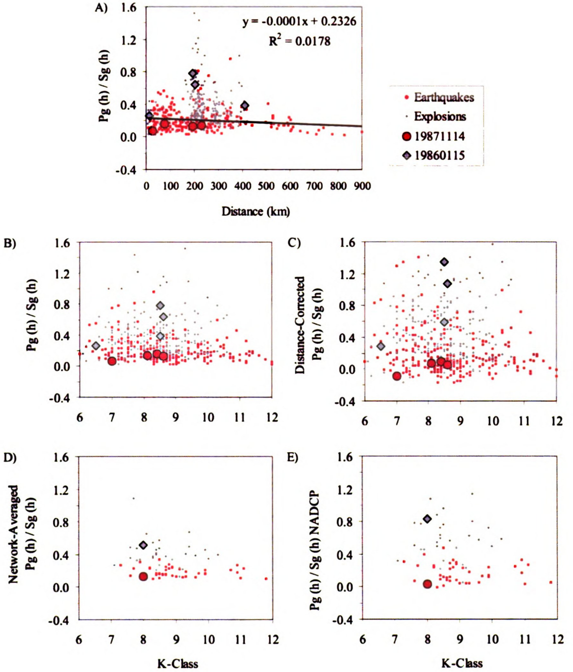


Figure 11. An example of a distance correction and network-average calculation for the Pg(h)/Sg(h) phase ratio of one earthquake and one explosion in the Southern Yakutia region. All of the Pg(h)/Sg(h) phase ratio for the region are also shown. See Table 6 for more details. A) Pg(h)/Sg(h) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(h)/Sg(h) phase ratio vs. K class. C) Pg(h)/Sg(h) phase ratio vs. K class after the application of the distance correction. D) Network-average Pg(h)/Sg(h) phase ratio vs. averaged K class. E) Network-averaged distance-corrected Pg(h)/Sg(h) phase ratio vs. averaged K class.

The difference between this regression line and each phase ratio was added to the original phase ratio (Fig. 11b) to obtain a distance-corrected phase (DCP) ratio which was plotted against K class. The same correction based on the linear regression for the earthquakes was also applied to the explosions (Fig. 11c).

Table 6 contains the data for the two events highlighted in Figure 11. It can be seen that the separation between the phase ratios from earthquakes is larger after the application of the distance correction. For this reason, the use of a distance correction improves the discriminating power of amplitude phase ratios as was seen in previous studies (Taylor, 1996; Hartse et al., 1997; Kim et al., 1997, and Mackey et al., 2005).

Table 6. An example of a distance correction and network average calculation for the Pg(h)/Sg(h) phase ratio of one earthquake and one explosion in the Southern Yakutia region

Event Date Time	Station	Dist. (km)	K class	$\frac{Pg(h)}{Sg(h)}$	$\frac{Pg(h)}{Sg(h)}$ DCP	$\frac{Pg(h)}{Sg(h)}$ NAP	$\frac{Pg(h)}{Sg(h)}$ NADCP	Average K class
Earthquake 1987 11 14 14 50 29.7	CLNS	231.8	8.1	0.14	0.07	0.13	0.03	8.0
	USZ	28.4	7.0	0.07	-0.09			
	TUG	78.6	8.4	0.16	0.10			
	UURS	193.6	8.6	0.13	0.05			
Explosion 1986 01 15 07 04 31.7	CLNS	11.8	6.5	0.26	0.29	0.52	0.83	8.0
	USZ	193.0	8.5	0.78	1.35			
	TUG	203.0	8.6	0.64	1.07			
	CGD	411.4	8.5	0.39	0.59			

DCP distance-corrected phase ratio, NAP network-averaged phase ratio, NADC network-averaged distance-corrected phase ratio.

2.2.2. The Network Average

It was found that in many cases a single event, either an earthquake or an explosion, had a very different value of the Pg/Sg phase ratio calculated for different stations. This difference in outliers between stations suggests that averaging the measurements over the seismic network may decrease the scatter and improve the earthquake-explosion separation. For this reason, a network-averaged phase (NAP) ratio was calculated when three or more phase ratios were available for the same event.

Figure 11 (d, e) shows an example of this procedure applied to the same set of data shown for the distance correction in the previous section. This average was calculated for both the phase ratios (Fig. 11d) and the distance-corrected phase ratios (Fig 11d) and were plotted against the network-averaged K class. Table 6 provides the results of these calculations. Network-averaged amplitude ratios were also used by Taylor et al. (1989), Taylor (1996), Walter et al. (1995, 1996), and Kim et al. (1997).

2.2.3. Critical Values

The critical value (CV) of a phase ratio is the value of the ratio that best separates the populations of earthquakes and explosions. Since it is intuitively expected that explosions should have higher values of Pg/Sg phase ratios than earthquakes, the critical values were calculated taking possible values of amplitude phase ratios and counting the number of ratios from earthquakes below that value and the number of ratios from explosions equal or above it.

Figure 12 shows an example of the procedure applied to the Pg(h)/Sg(h) phase ratios in the Magadan and Northern Yakutia regions. The analysis was performed by iterations every 0.01 of the value of the phase ratio from -0.4 to 5 (Table 7). The sum of the number of earthquakes below each value and the explosions equal or above it for one specific value define the number of ratios correctly classified by that value. The maximum number of correctly classified events determines the critical value for the phase ratio analyzed (Fig. 12 a,b).

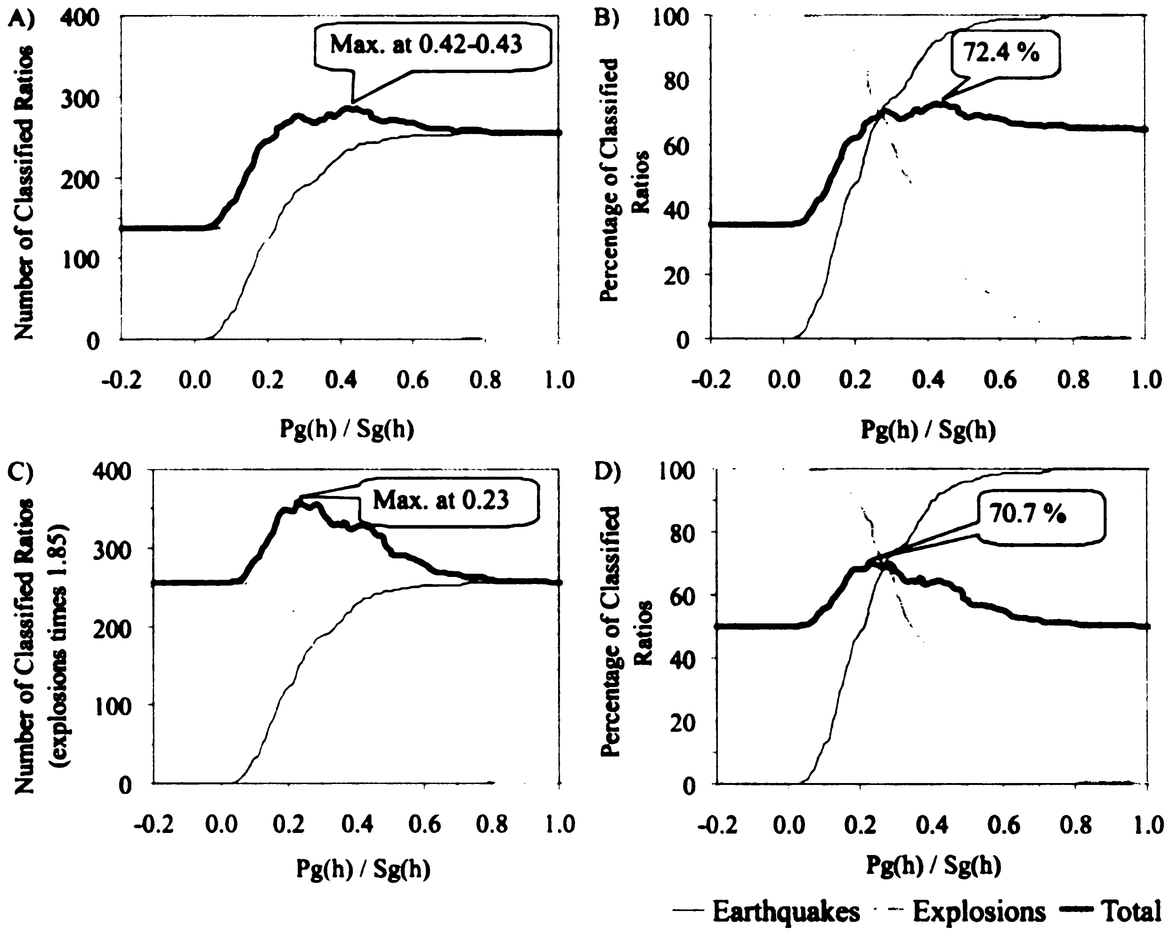


Fig 12. An example of the calculation of the critical value for the Pg(h)/Sg(h) phase ratio for the Magadan and Northern Yakutia regions. Additional details in Table 7. A) Number of correctly classified ratios by the Pg(h)/Sg(h) phase ratio. B) Percentage of correctly classified ratios by the Pg(h)/Sg(h) phase ratio. C) Number of correctly classified ratios after an EEF of 1.85 was applied to the number of explosions. D) Percentage of correctly classified ratios after an EEF of 1.85 was applied to the number of explosions.

Table 7. An example of the calculation of the critical values for the Pg(h)/Sg(h) phase ratio in the Magadan and Northern Yakutia regions. Iterations are only shown completely for a window from 0.20 to 0.50 of the critical values (see also Fig. 12)

Critical Value (CV)	Earthquakes below CV		Explosions equal or above CV		Total correctly classified by CV		Explosions times a EEF of 1.85 equal or above CV		Total correctly classified after EEF	
	Num.	%	Num.	%	Num.	%	Num.	%	Total	%
0.00	0.0	0.0	138.0	100.0	138.0	35.1	255.0	100.0	255.0	50.0
0.10	32.0	12.5	137.0	99.3	169.0	43.0	253.2	99.3	285.2	55.9
0.20	123.0	48.2	122.0	88.4	245.0	62.3	225.4	88.4	348.4	68.3
0.21	126.0	49.4	120.0	87.0	246.0	62.6	221.7	87.0	347.7	68.2
0.22	135.0	52.9	116.0	84.1	251.0	63.9	214.3	84.1	349.3	68.5
0.23	148.0	58.0	115.0	83.3	263.0	66.9	212.5	83.3	360.5	70.7
0.24	156.0	61.2	107.0	77.5	263.0	66.9	197.7	77.5	353.7	69.4
0.25	166.0	65.1	102.0	73.9	268.0	68.2	188.5	73.9	354.5	69.5
0.26	170.0	66.7	98.0	71.0	268.0	68.2	181.1	71.0	351.1	68.8
0.27	175.0	68.6	96.0	69.6	271.0	69.0	177.4	69.6	352.4	69.1
0.28	183.0	71.8	94.0	68.1	277.0	70.5	173.7	68.1	356.7	69.9
0.29	186.0	72.9	91.0	65.9	277.0	70.5	168.2	65.9	354.2	69.4
0.30	189.0	74.1	85.0	61.6	274.0	69.7	157.1	61.6	346.1	67.9
0.31	190.0	74.5	81.0	58.7	271.0	69.0	149.7	58.7	339.7	66.6
0.32	192.0	75.3	77.0	55.8	269.0	68.4	142.3	55.8	334.3	65.5
0.33	195.0	76.5	72.0	52.2	267.0	67.9	133.0	52.2	328.0	64.3
0.34	199.0	78.0	70.0	50.7	269.0	68.4	129.3	50.7	328.3	64.4
0.35	204.0	80.0	68.0	49.3	272.0	69.2	125.7	49.3	329.7	64.6
0.36	208.0	81.6	65.0	47.1	273.0	69.5	120.1	47.1	328.1	64.3
0.37	215.0	84.3	64.0	46.4	279.0	71.0	118.3	46.4	333.3	65.3
0.38	218.0	85.5	57.0	41.3	275.0	70.0	105.3	41.3	323.3	63.4
0.39	222.0	87.1	55.0	39.9	277.0	70.5	101.6	39.9	323.6	63.5
0.40	228.0	89.4	54.0	39.1	282.0	71.8	99.8	39.1	327.8	64.3
0.41	230.0	90.2	53.0	38.4	283.0	72.0	97.9	38.4	327.9	64.3
0.42	234.0	91.8	51.0	37.0	285.0	72.5	94.2	37.0	328.2	64.4
0.43	235.0	92.2	50.0	36.2	285.0	72.5	92.4	36.2	327.4	64.2
0.44	236.0	92.5	48.0	34.8	284.0	72.3	88.7	34.8	324.7	63.7
0.45	239.0	93.7	46.0	33.3	285.0	72.5	85.0	33.3	324.0	63.5
0.46	241.0	94.5	41.0	29.7	282.0	71.8	75.8	29.7	316.8	62.1
0.47	241.0	94.5	40.0	29.0	281.0	71.5	73.9	29.0	314.9	61.7
0.48	243.0	95.3	39.0	28.3	282.0	71.8	72.1	28.3	315.1	61.8
0.49	244.0	95.7	30.0	21.7	274.0	69.7	55.4	21.7	299.4	58.7
0.50	244.0	95.7	30.0	21.7	274.0	69.7	55.4	21.7	299.4	58.7
0.70	252.0	98.8	8.0	5.8	260.0	66.2	14.8	5.8	266.8	52.3
0.90	255.0	100.0	1.0	0.7	256.0	65.1	1.8	0.7	256.8	50.4
1.00	255.0	100.0	0.0	0.0	255.0	64.9	0.0	0.0	255.0	50.0

EEF. Explosion Equalization Factor

The number of ratios calculated from earthquakes was higher than the number of explosions in each of the studied regions. In order to calculate the critical values, an equal amount of phase ratios is desirable for both earthquakes and explosions. For this reason, the number of explosions was multiplied by a factor named here as Explosion Equalization Factor (EEF), which is equal to the fraction of earthquakes to explosions in each region. Figure 12 (c,d) shows the results after multiplying a EEF of 1.85 to the explosions.

2.2.4. Performance of Discriminants

A qualitative scale was defined to describe the performance of the discriminants in three categories: good, fair, and poor. Good means that ratio populations are completely or nearly separated with at least 85.0% of the ratios correctly classified by the critical value. Fair means that ratio populations are separated between 75.0 and 84.9%. Poor means that there is a considerable overlap between event populations with less than 74.9% of the events correctly classified.

2.3. Southern Yakutia

Amplitude information from 147 earthquakes ($5.2 < K < 12.6$, $10 < \Delta < 900$ km) and 117 explosions ($4.8 < K < 10.6$, $6 < \Delta < 514$ km) was used to calculate 323 Pg(z)/Sg(h) phase ratios from earthquakes and 251 from explosions, and 259 phase ratios of the other four types from earthquakes and 206 from explosions (Table 5). The distribution by time, K class, epicentral distance, and seismic station of the phase ratios calculated from stations with amplitude information in all components is shown in Figure 13.

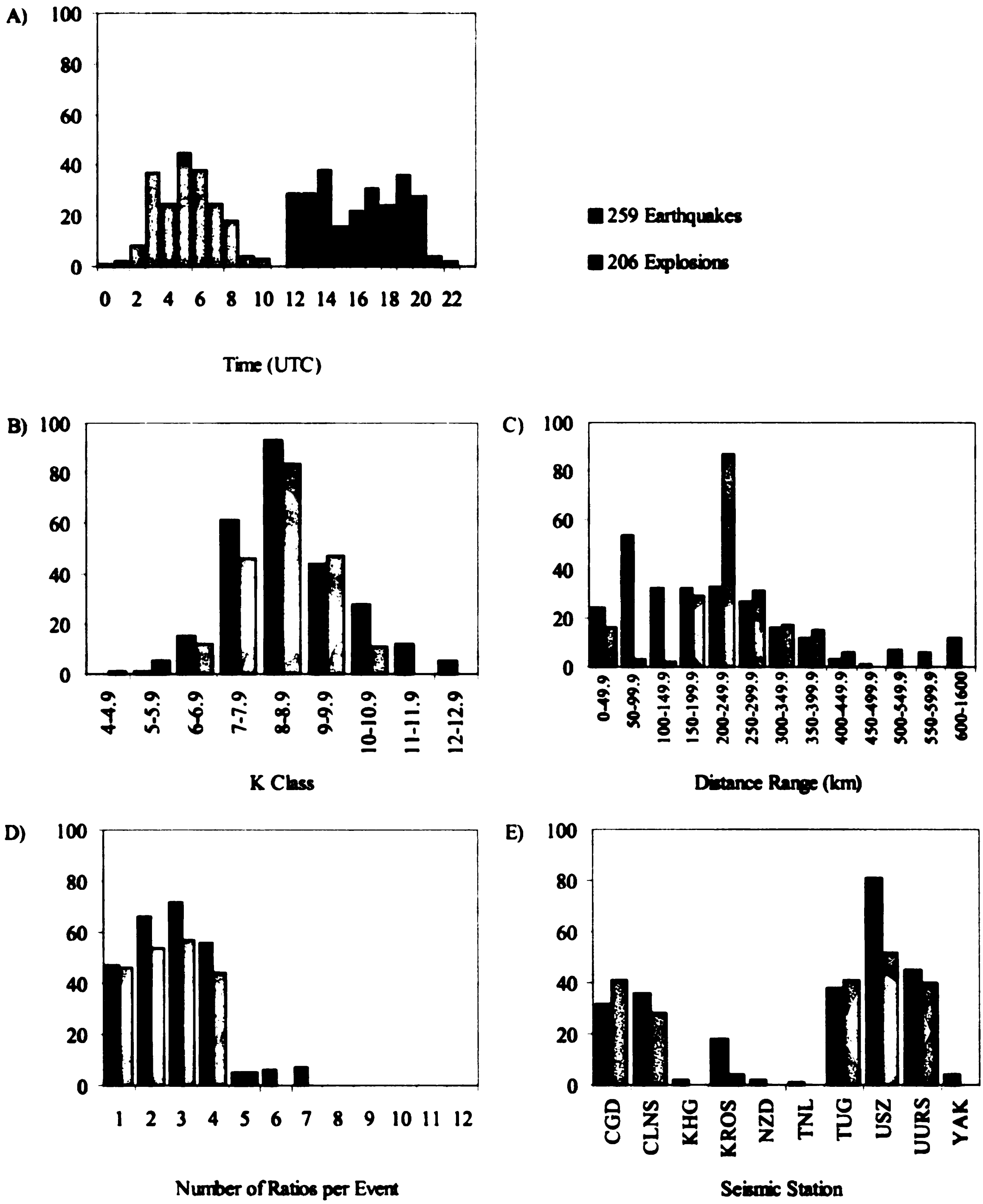


Figure 13. Distribution of phase ratios calculated from amplitude information in all components for the Southern Yakutia region. A) By time. B) By K class. C) By epicentral distance. D) By maximum number of ratios per event. E) By seismic station.

The time window used for the selection of explosions was 23:00-10:59 UTC, while the window for earthquakes was 11:00-22:59 (Fig. 13a). The majority of the ratios (~ 81%) were from events that have a K class between 7 and 10 ($2.3 < m_b < 3.6$, Fig. 13b). Most of the ratios calculated from explosions (~ 66%) are located in the Neryungri -Chulman mining region (56-58°N and 124-126°E, Fig. 10). The distribution of explosions by epicentral distance is concentrated (~ 42%) around 200 to 250 km, which is the distance between the Neryungri -Chulman region and seismic stations USZ, UURS, and TUG that recorded the majority of the events. In contrast to explosions, the epicentral distribution of earthquakes is more scattered and therefore has a more uniform distribution by epicentral distance, especially between 100 and 300 km (Fig 10 and 13c).

Approximately 54% of the phase ratios calculated came from events with amplitude information in all components from at least three stations (Fig. 13d). This represents 41 earthquakes and 31 explosions that could be averaged over the network, as explained in the methodology. Since more amplitude information could be used to create Pg(z)/Sg(h) phase ratios, 51 earthquakes and 42 explosions could be averaged over the network for this specific ratio. Most of the phase ratios from both earthquakes and explosions were calculated from amplitudes recorded at stations USZ (~ 28%), UURS (~ 18%), TUG (~ 17%), CGD (~ 16%), and CLNS (~ 14%), as shown in Figure 13e.

2.3.1. Results

There was a clear tendency of the amplitude ratios from explosions to have higher values than earthquakes in all cases. However, a considerable overlap between the two types of events was also noticed, especially in the cases where the phase ratios were not averaged over the network.

The results of the five types of amplitude ratios obtained are shown as follows: raw phase ratios in Figures 14 to 18, DCP ratios in Figures 19 to 23, NAP ratios in Figures 24-28, and NADCP ratios in Figures 29-33. Each figure describes one specific phase ratio using a plot of the amplitude ratio vs. K class, a histogram of the amplitude ratio, and two graphs showing the number and percentage of correctly classified events by the different values of the phase ratio. In order to compare the phase ratio before and after the application of the distance correction, a plot of the phase ratio vs. distance and the phase ratio vs. K class is also shown in the case of the DCP ratio (Fig. 19-23). Figure 34 shows a comparison of the values of all types of amplitude ratios.

Table 8 provides the results of all phase ratio vs. distance regressions used for the Southern Yakutia region. As indicated by the low values of the coefficient of determination, there is a very weak phase ratio vs. distance trend (Fig 19a-23a). These linear regressions were used to calculate the distance-corrected phase ratios shown in Figures 19c-23c.

Table 9 and Figure 35 contain averages and standard deviations of earthquake and explosion populations of all types of amplitude ratios calculated in the Southern Yakutia region. In all cases, the average of amplitude phase ratios for explosions is higher than earthquakes. As shown in Table 9, Pg(z)/Sg(h) amplitude ratios usually had the lowest standard deviation for both earthquakes and explosions compared to the rest phase of the amplitudes ratios calculated using the same technique. On the other hand, the Pg(h)/Sg(z) amplitude ratios always had the highest standard deviation for both types of events (Fig. 35). Both Pg(h)/Sg(h) and full vector phase ratios had similar standard deviations to the Pg(z)/Sg(h) phase ratios.

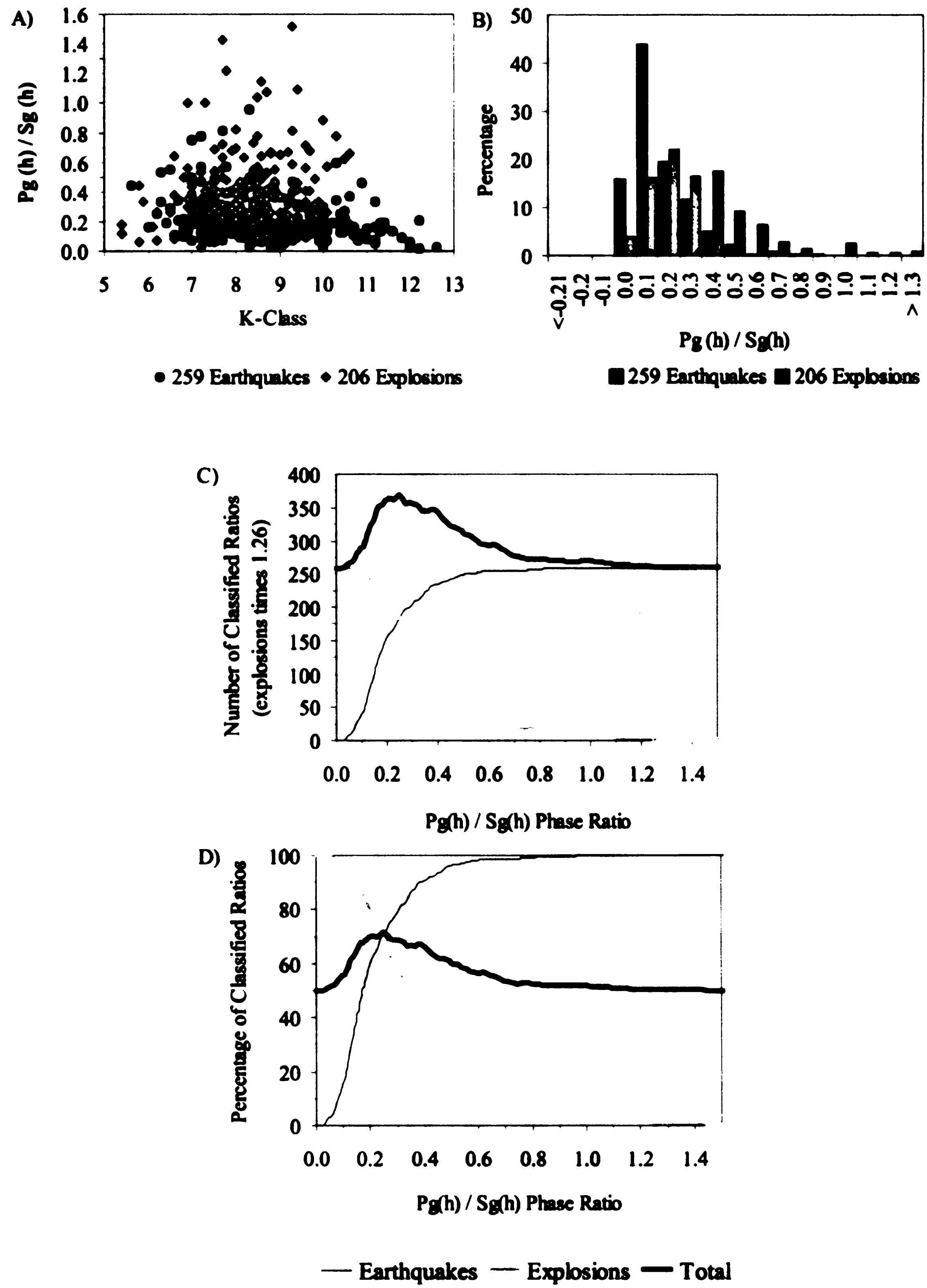


Figure 14. Pg(h)/Sg(h) raw phase ratio for the Southern Yakutia region. A) Pg(h)/Sg(h) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

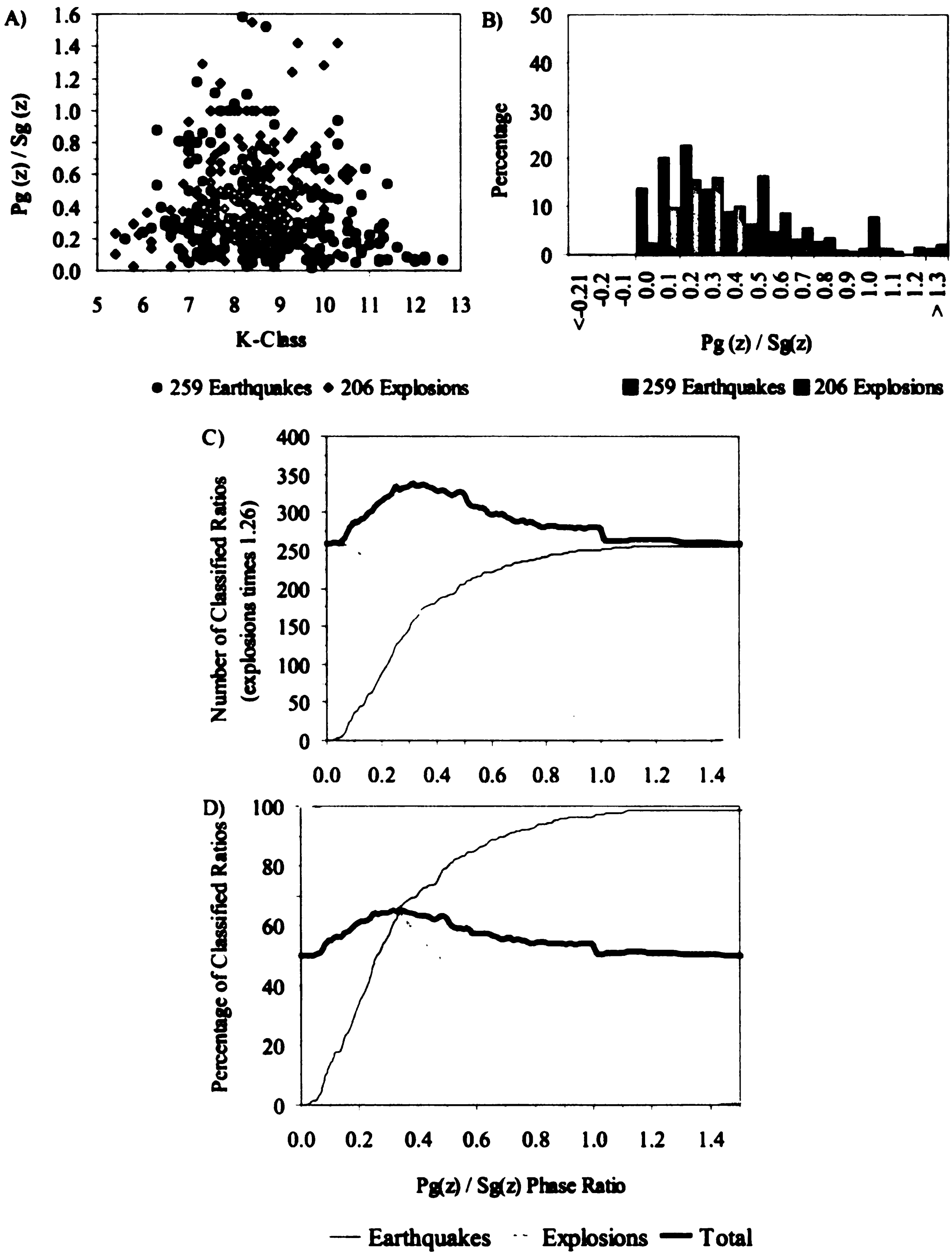


Figure 15. Pg(z)/Sg(z) raw phase ratio for the Southern Yakutia region. A) Pg(z)/Sg(z) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

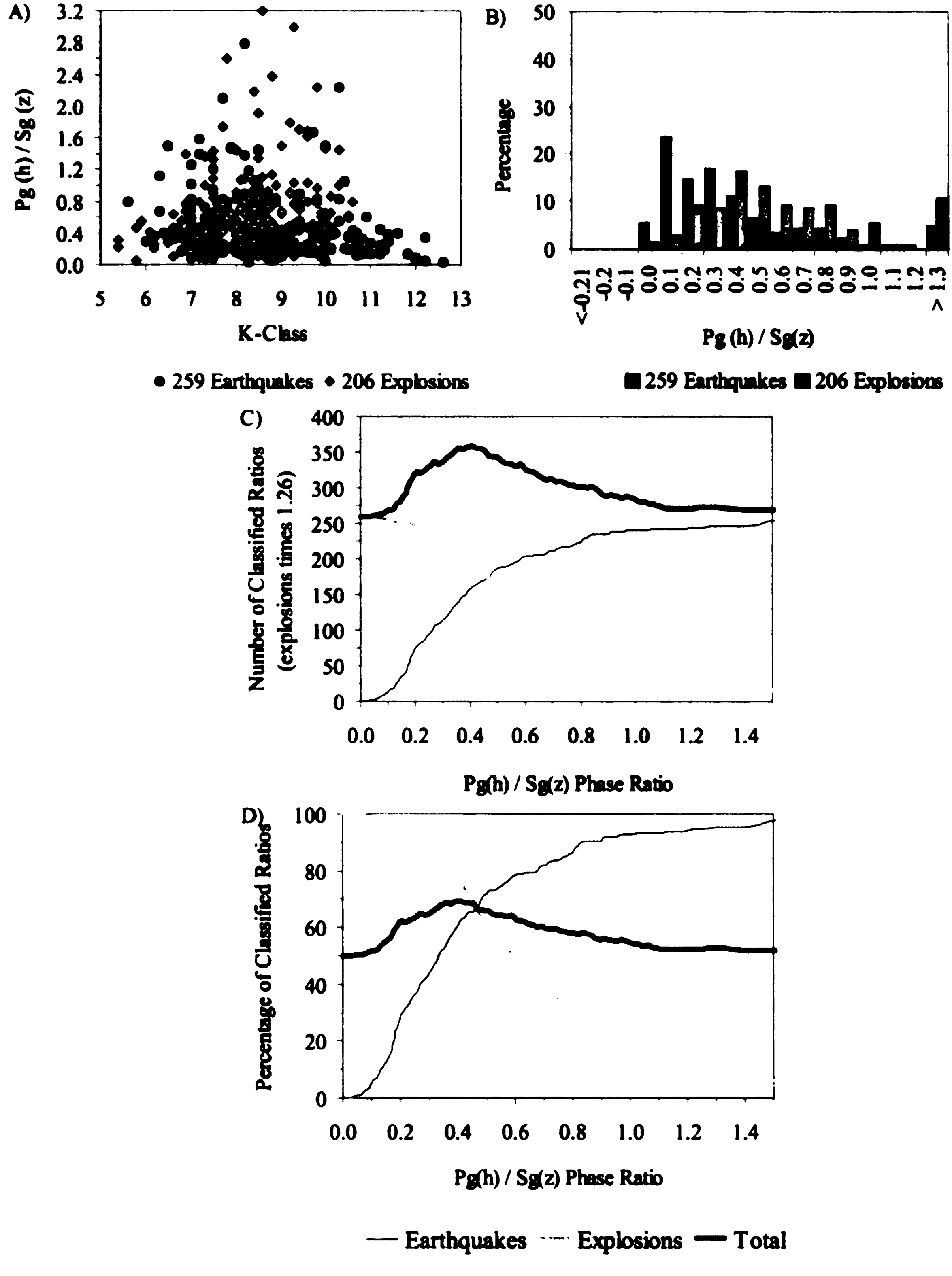


Figure 16. Pg(h)/Sg(z) raw phase ratio for the Southern Yakutia region. A) Pg(h)/Sg(z) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

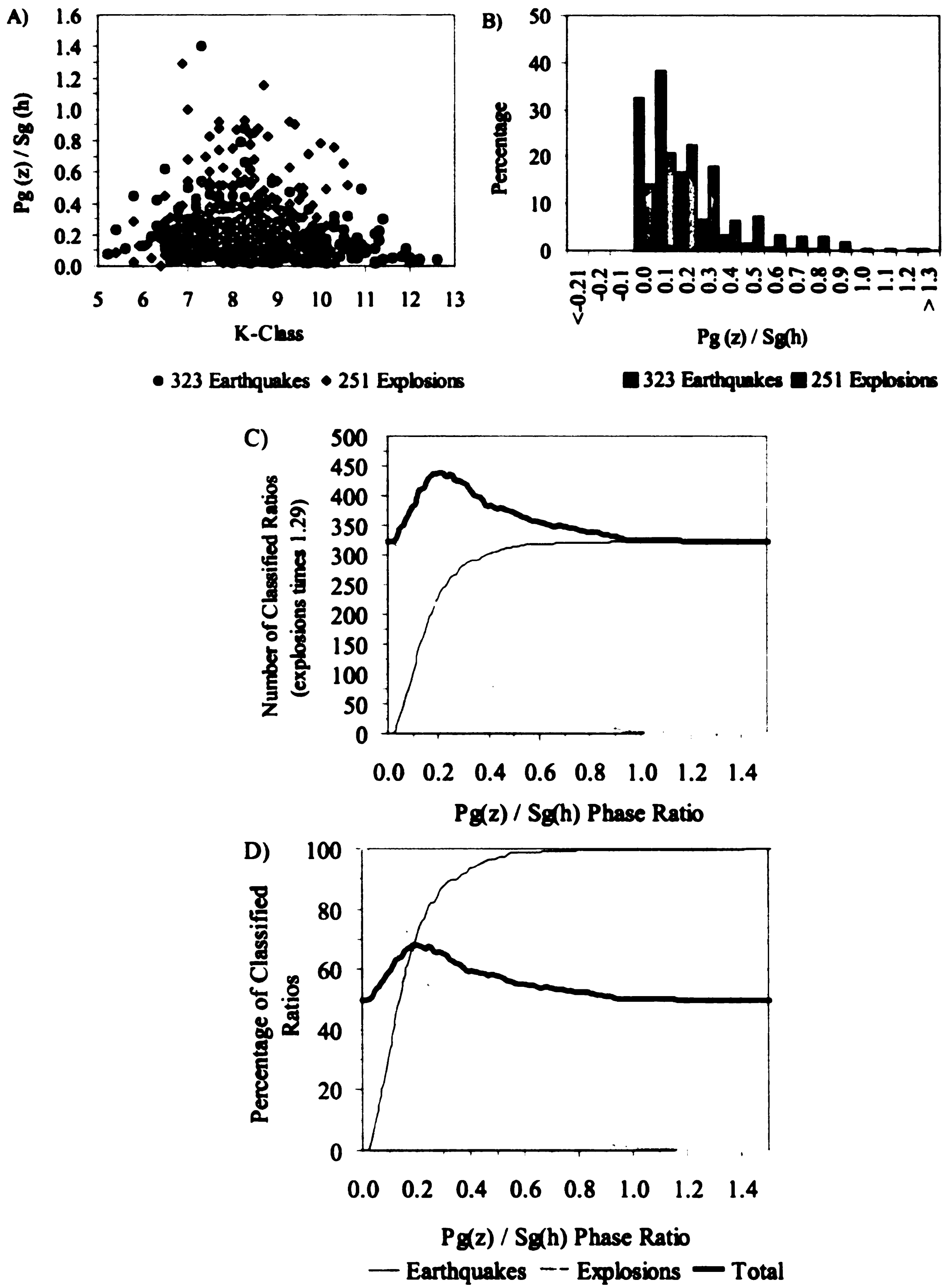


Figure 17. Pg(z)/Sg(h) raw phase ratio for the Southern Yakutia region. A) Pg(z)/Sg(h) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

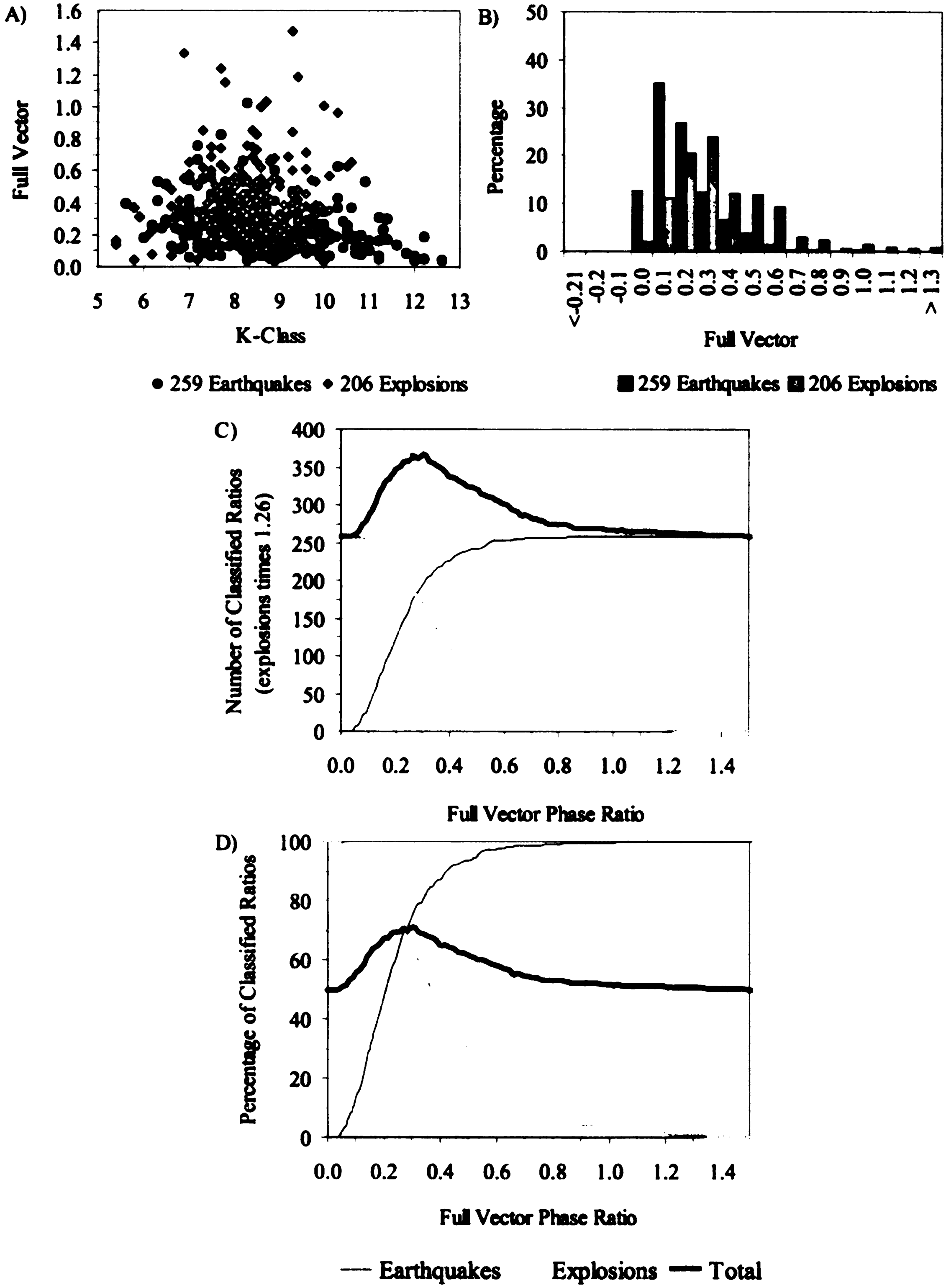


Figure 18. Full vector raw phase ratio for the Southern Yakutia region. A) Full vector vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

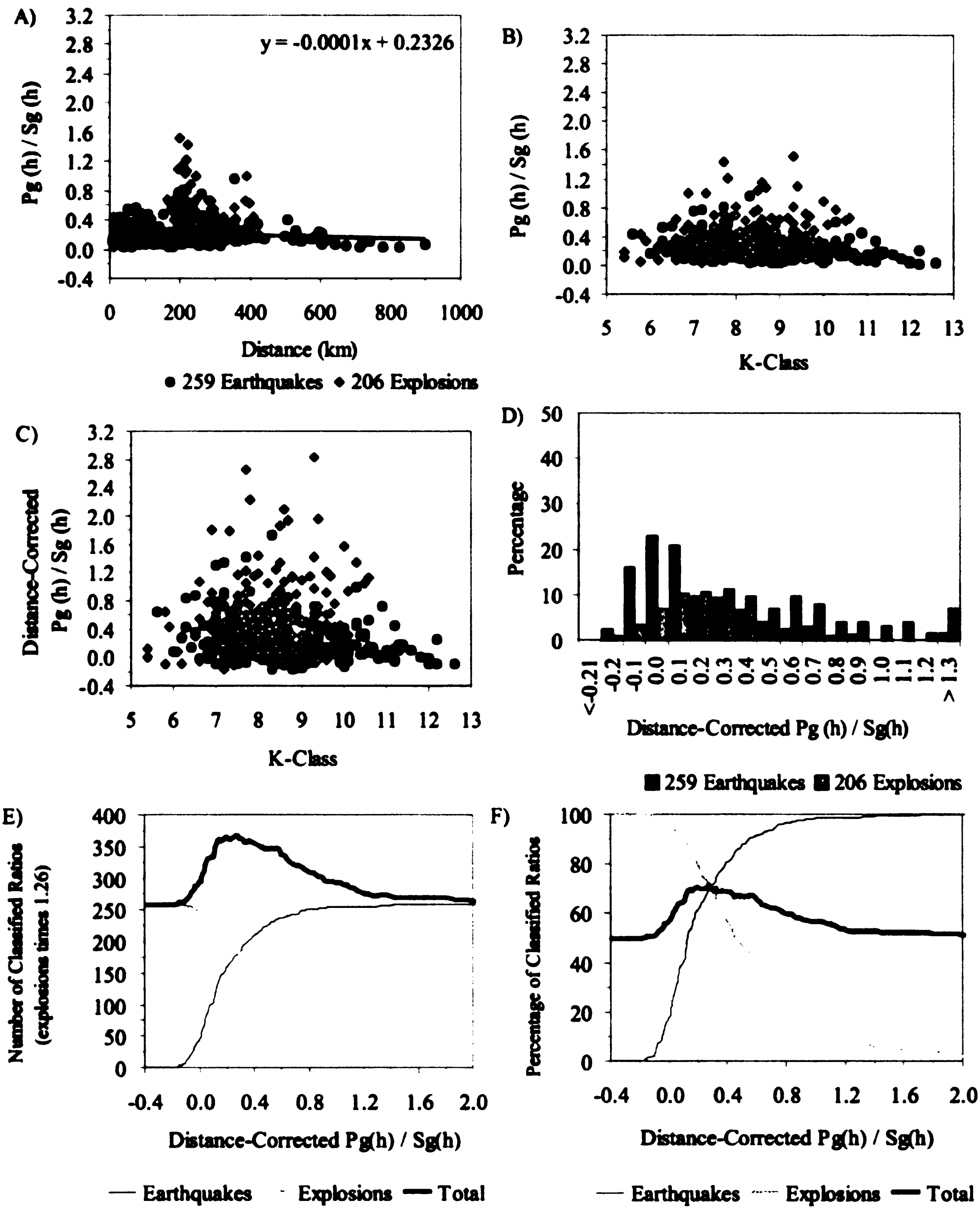


Figure 19. Pg(h)/Sg(h) DCP ratio for the Southern Yakutia Region. A) Pg(h)/Sg(h) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(h)/Sg(h) phase ratio vs. K class. C) Pg(h)/Sg(h) DCP ratio vs. K class. D). Histogram. E) Number of correctly classified events. F) Percentage of correctly classified events.

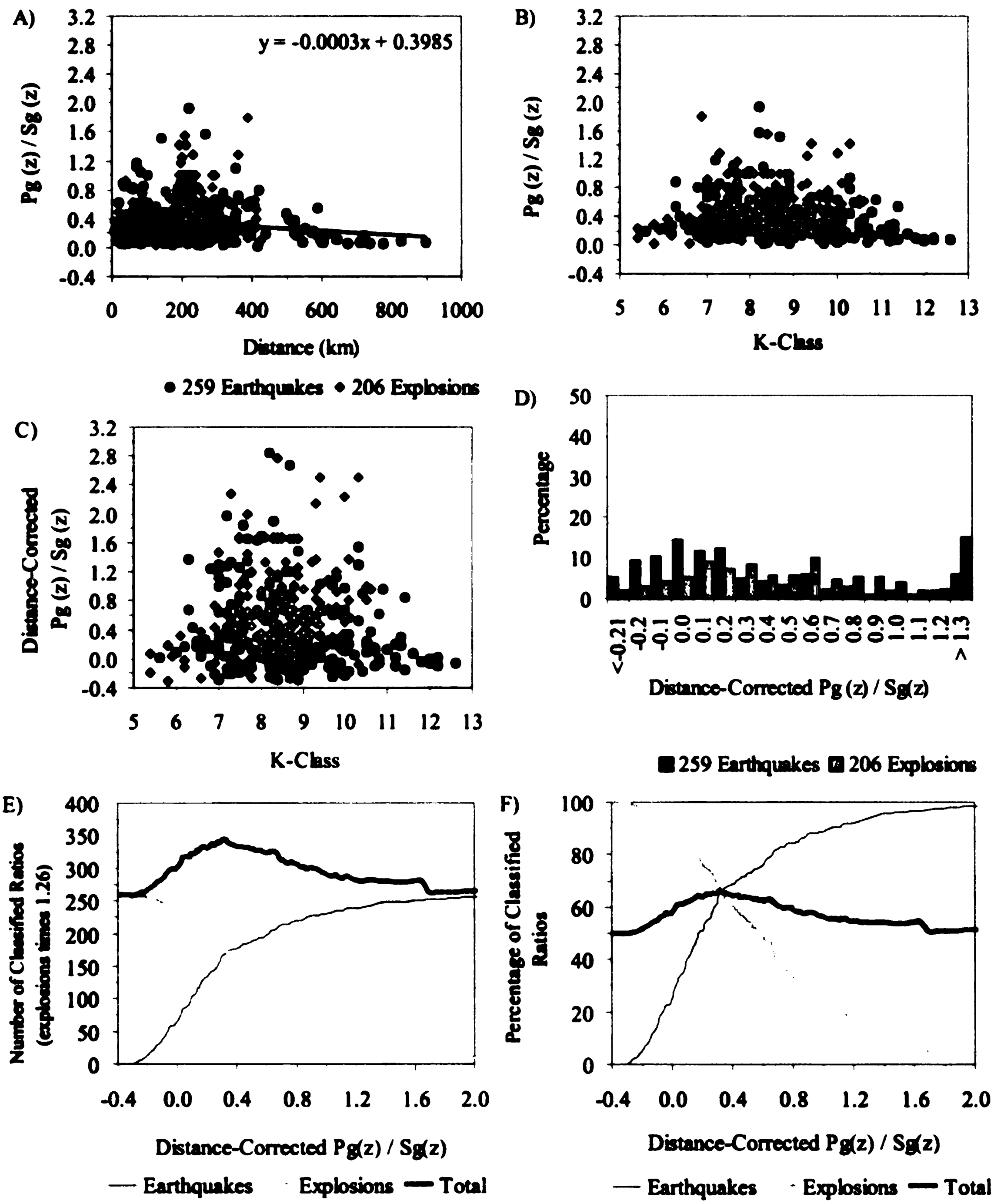


Figure 20. Pg(z)/Sg(z) DCP ratio for the Southern Yakutia Region. A) Pg(z)/Sg(z) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(z)/Sg(z) phase ratio vs. K class. C) Pg(z)/Sg(z) DCP ratio vs. K class. D). Histogram. E) Number of correctly classified events. F) Percentage of correctly classified events.

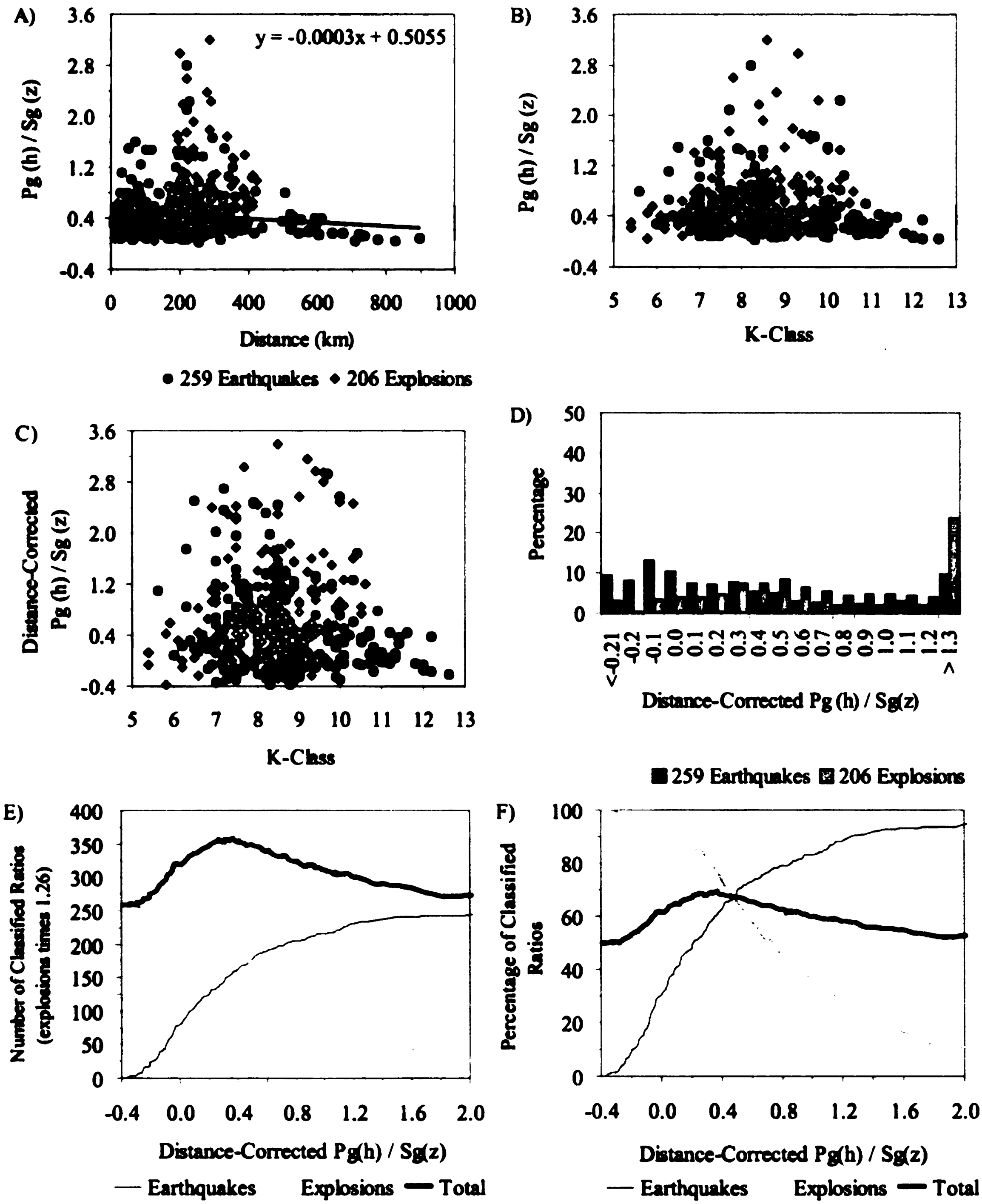


Figure 21. Pg(h)/Sg(z) DCP ratio for the Southern Yakutia Region. A) Pg(h)/Sg(z) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(h)/Sg(z) phase ratio vs. K class. C) Pg(h)/Sg(z) DCP ratio vs. K class. D). Histogram. E) Number of correctly classified events. F) Percentage of correctly classified events.

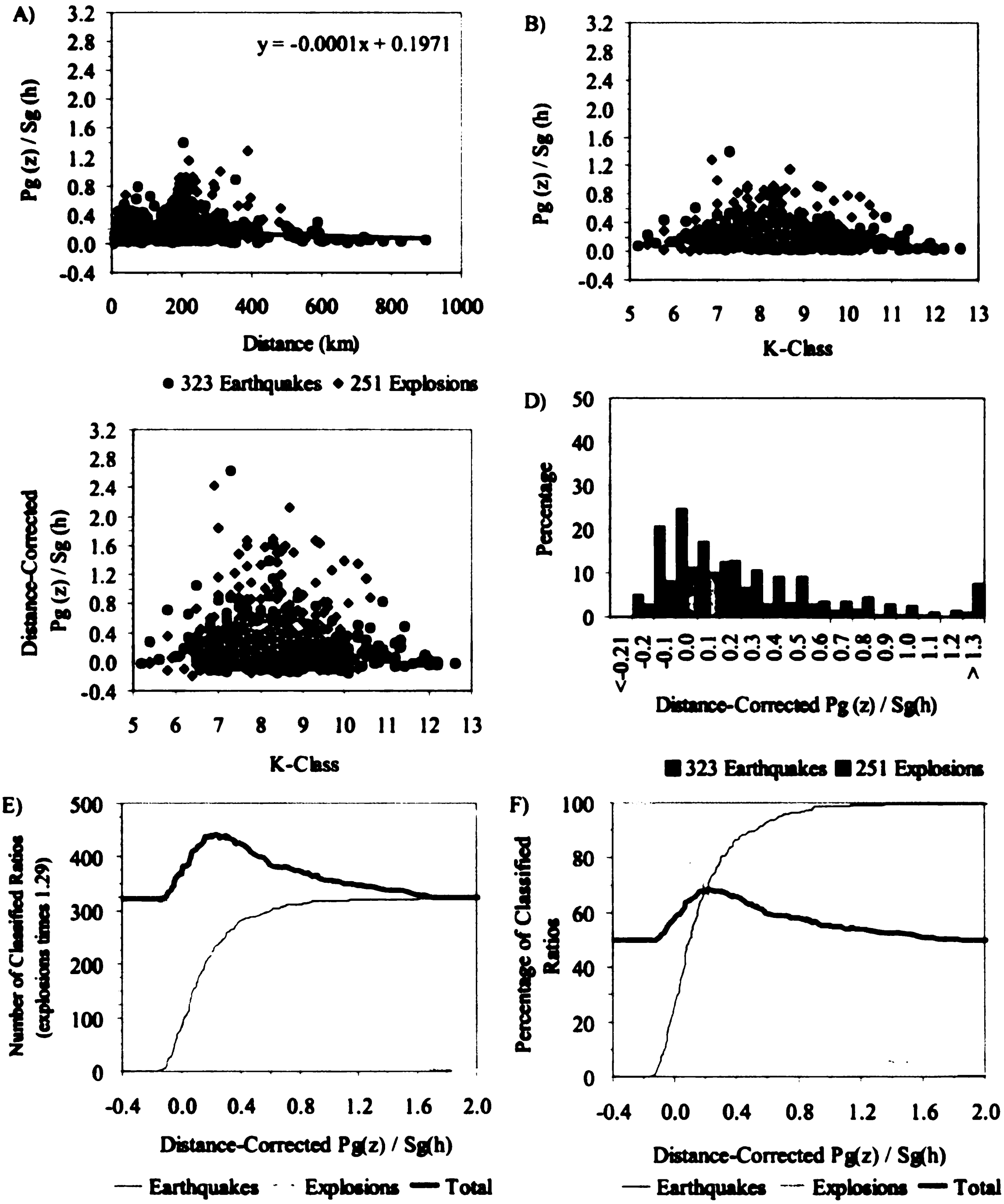


Figure 22. Pg(z)/Sg(h) DCP ratio for the Southern Yakutia Region. A) Pg(z)/Sg(h) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(z)/Sg(h) phase ratio vs. K class. C) Pg(z)/Sg(h) DCP ratio vs. K class. D). Histogram. E) Number of correctly classified events. F) Percentage of correctly classified events.

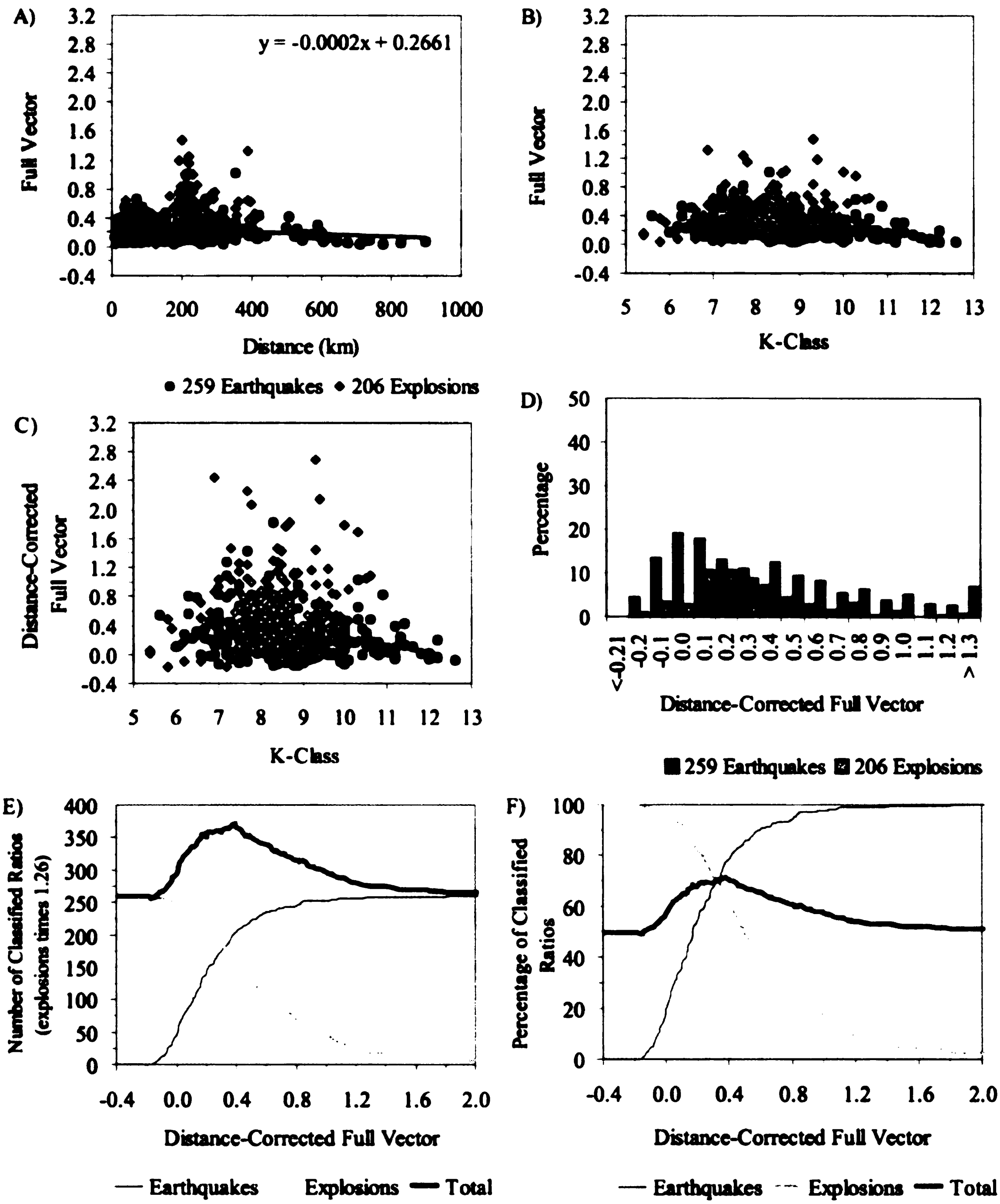


Figure 23. Full vector DCP ratio for the Southern Yakutia Region. A) Full vector phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Full vector phase ratio vs. K class. C) Full vector DCP ratio vs. K class. D). Histogram. E) Number of correctly classified events. F) Percentage of correctly classified events.

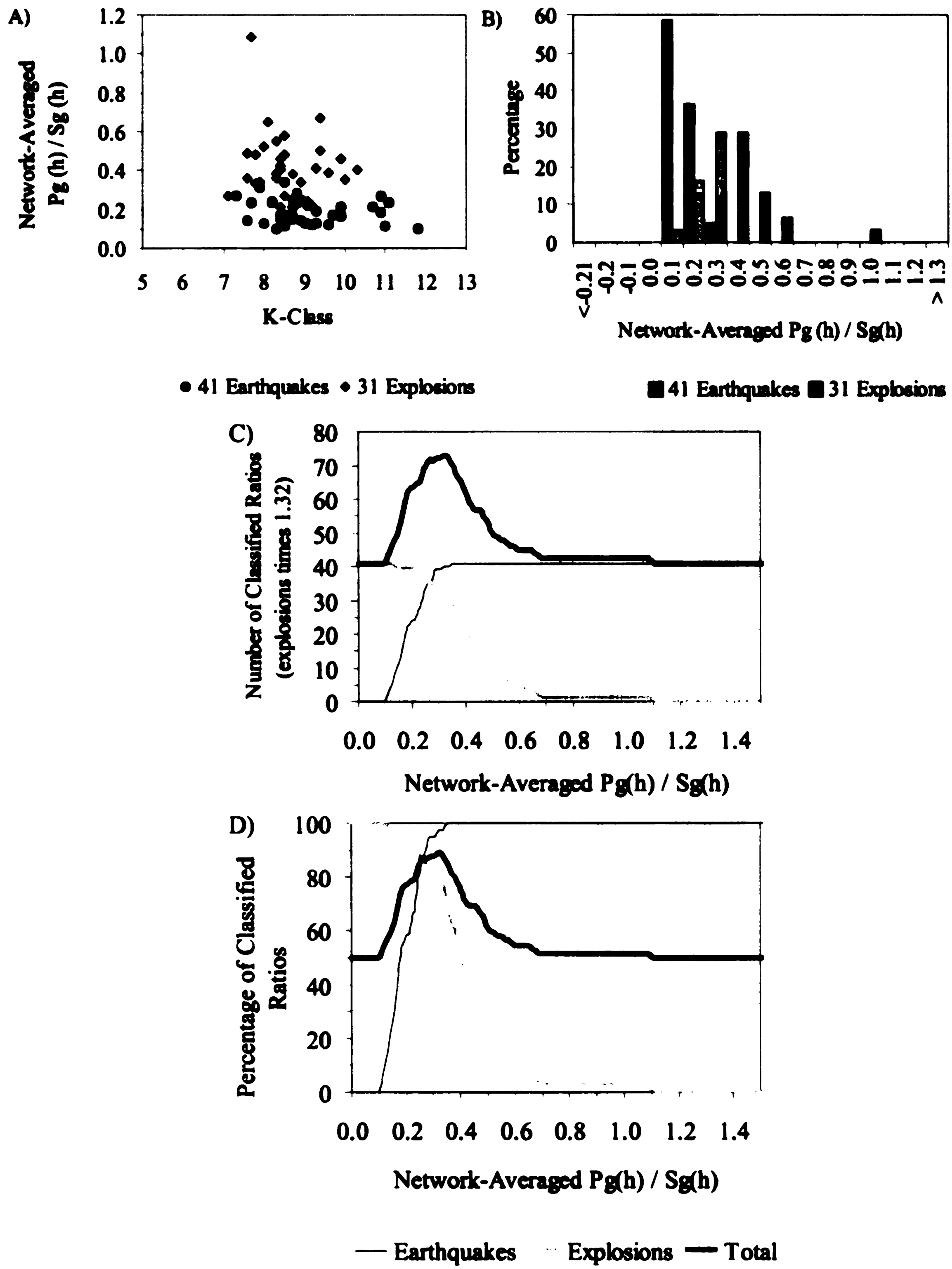


Figure 24. Pg(h)/Sg(h) NAP ratio for the Southern Yakutia Region. A) Pg(h)/Sg(h) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

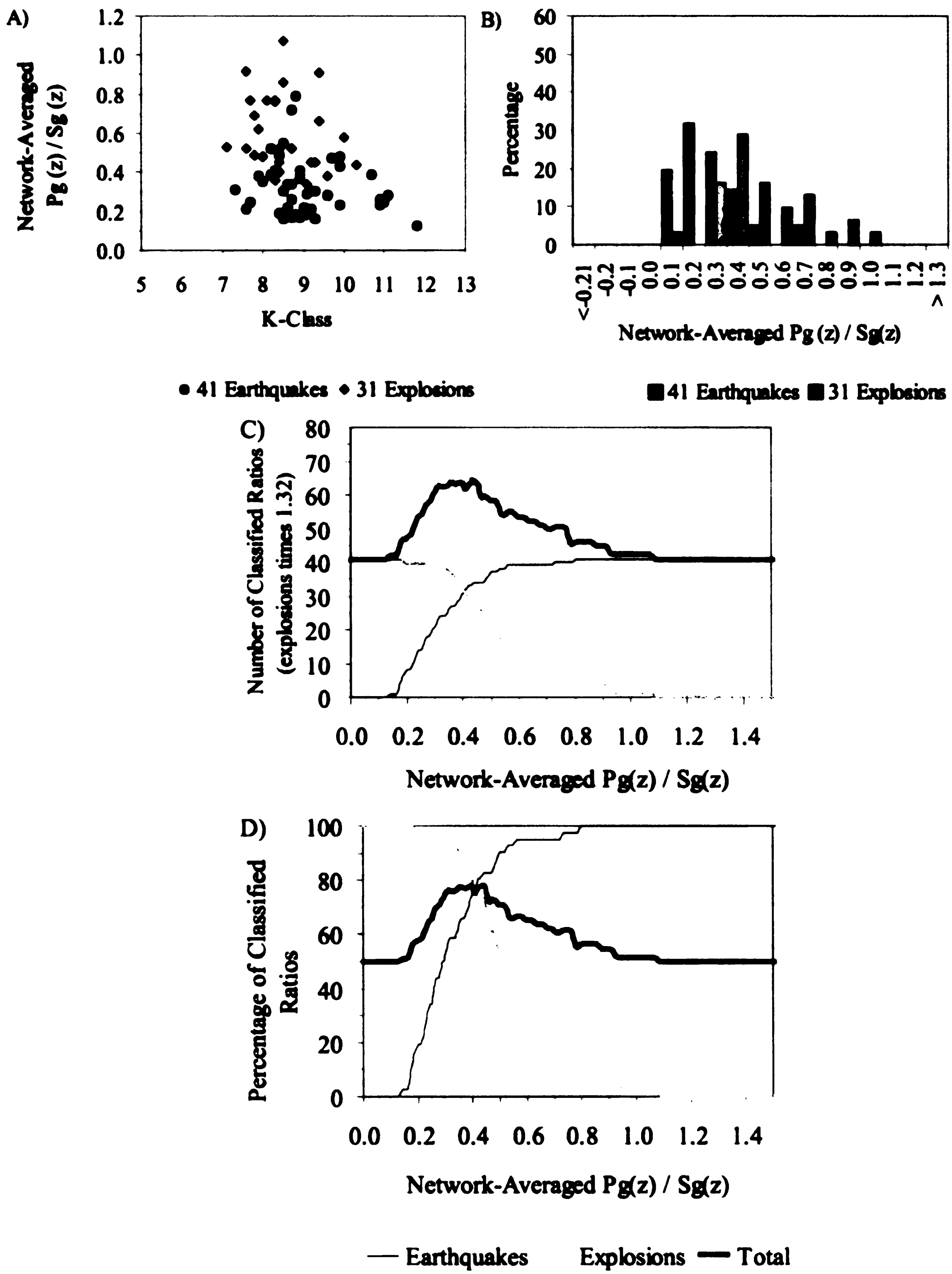


Figure 25. Pg(z)/Sg(z) NAP ratio for the Southern Yakutia Region. A) Pg(z)/Sg(z) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

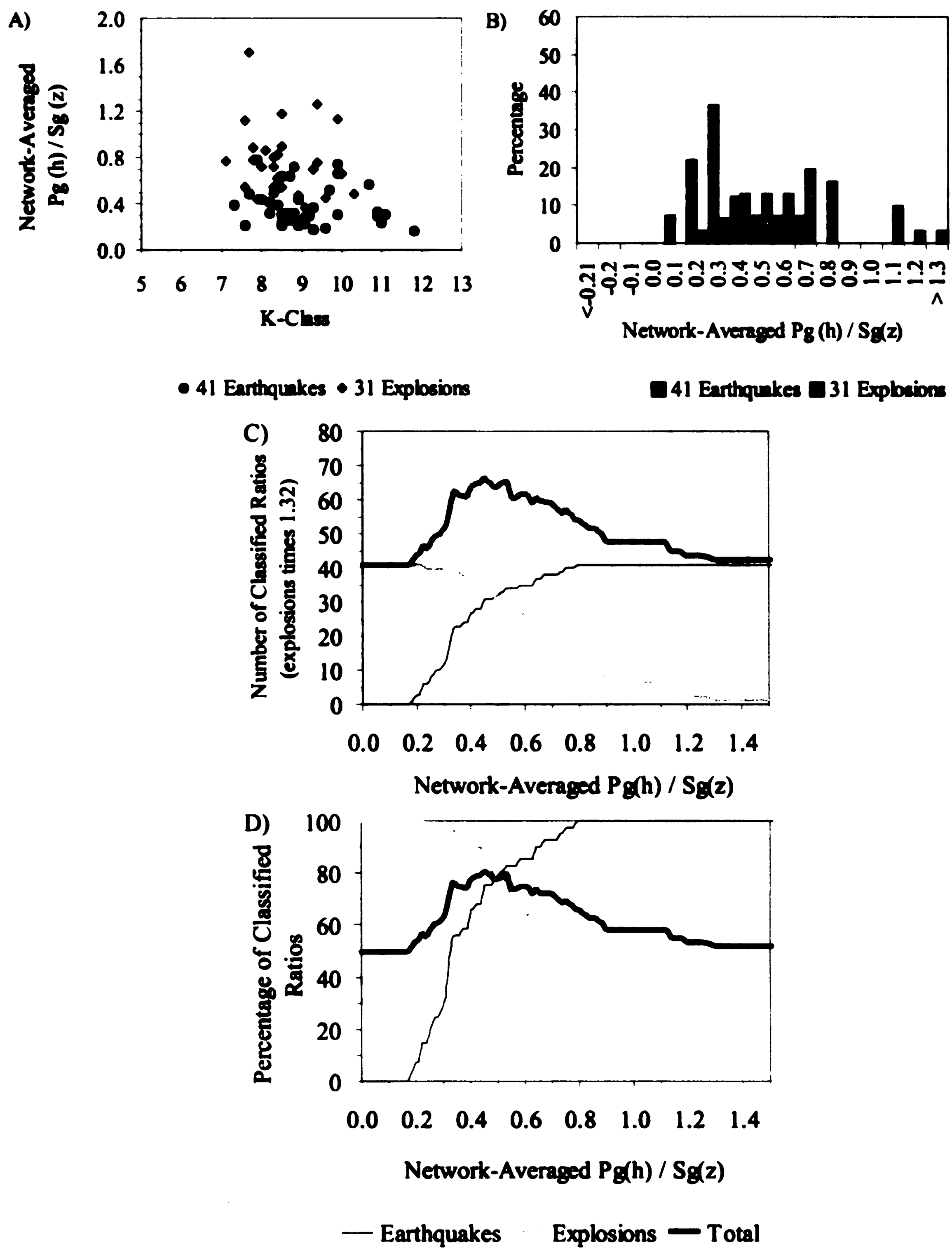


Figure 26. Pg(h)/Sg(z) NAP ratio for the Southern Yakutia Region. A) Pg(h)/Sg(z) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

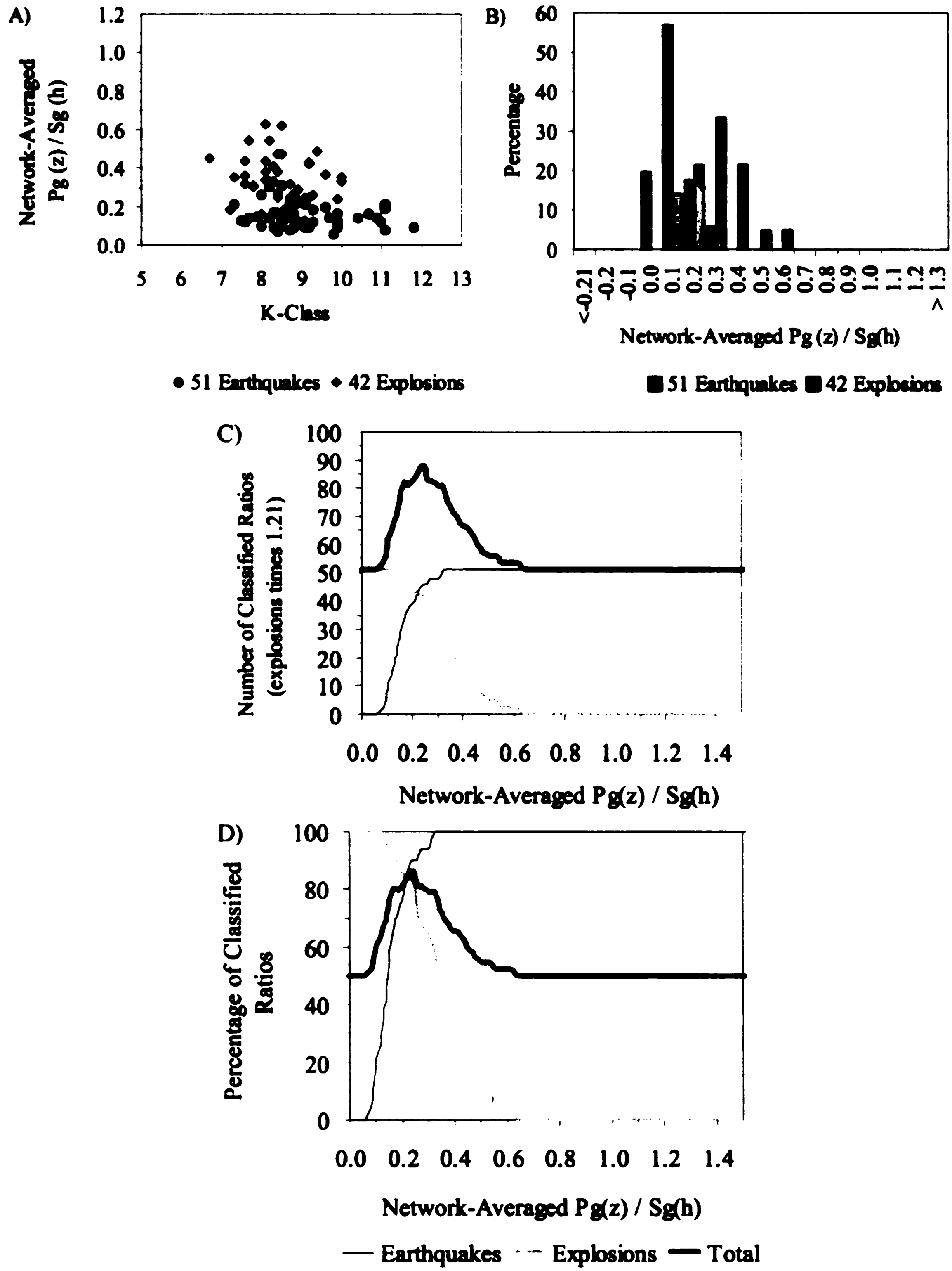


Figure 27. Pg(z)/Sg(h) NAP ratio for the Southern Yakutia Region. A) Pg(z)/Sg(h) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

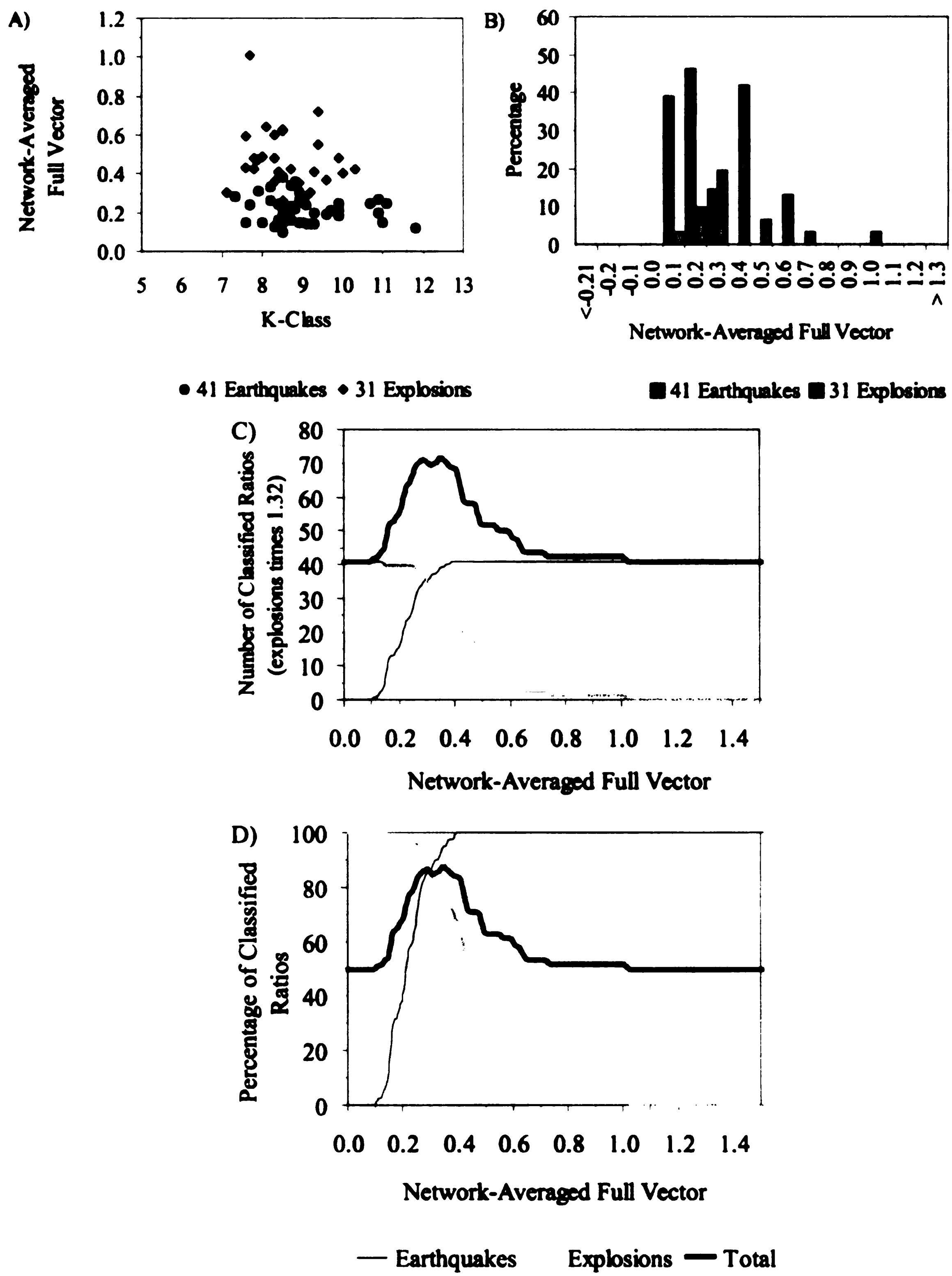


Figure 28. Full vector NAP ratio for the Southern Yakutia Region. A) Full vector NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

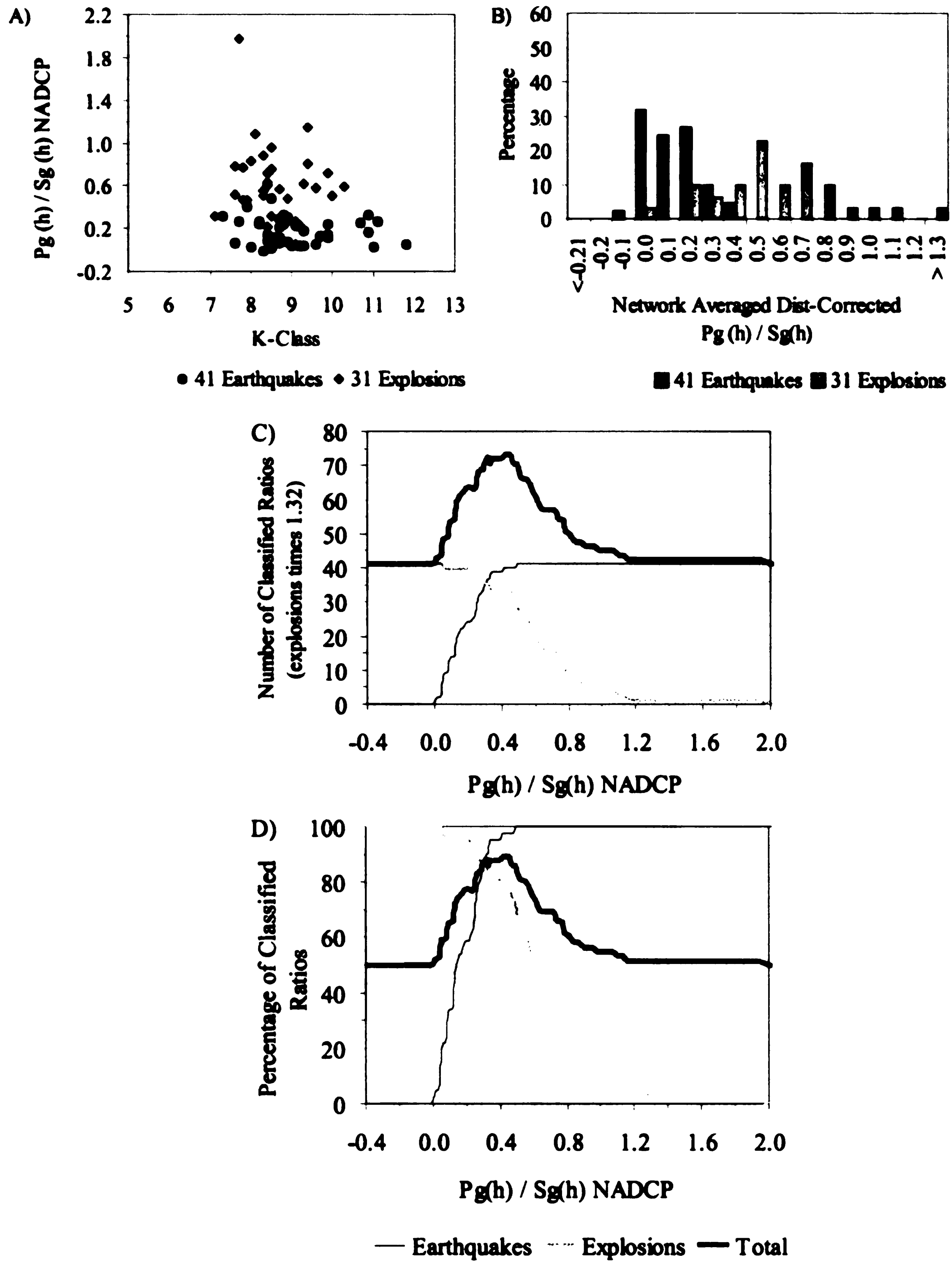


Figure 29. Pg(h)/Sg(h) NADCP ratio for the Southern Yakutia Region. A) Pg(h)/Sg(h) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

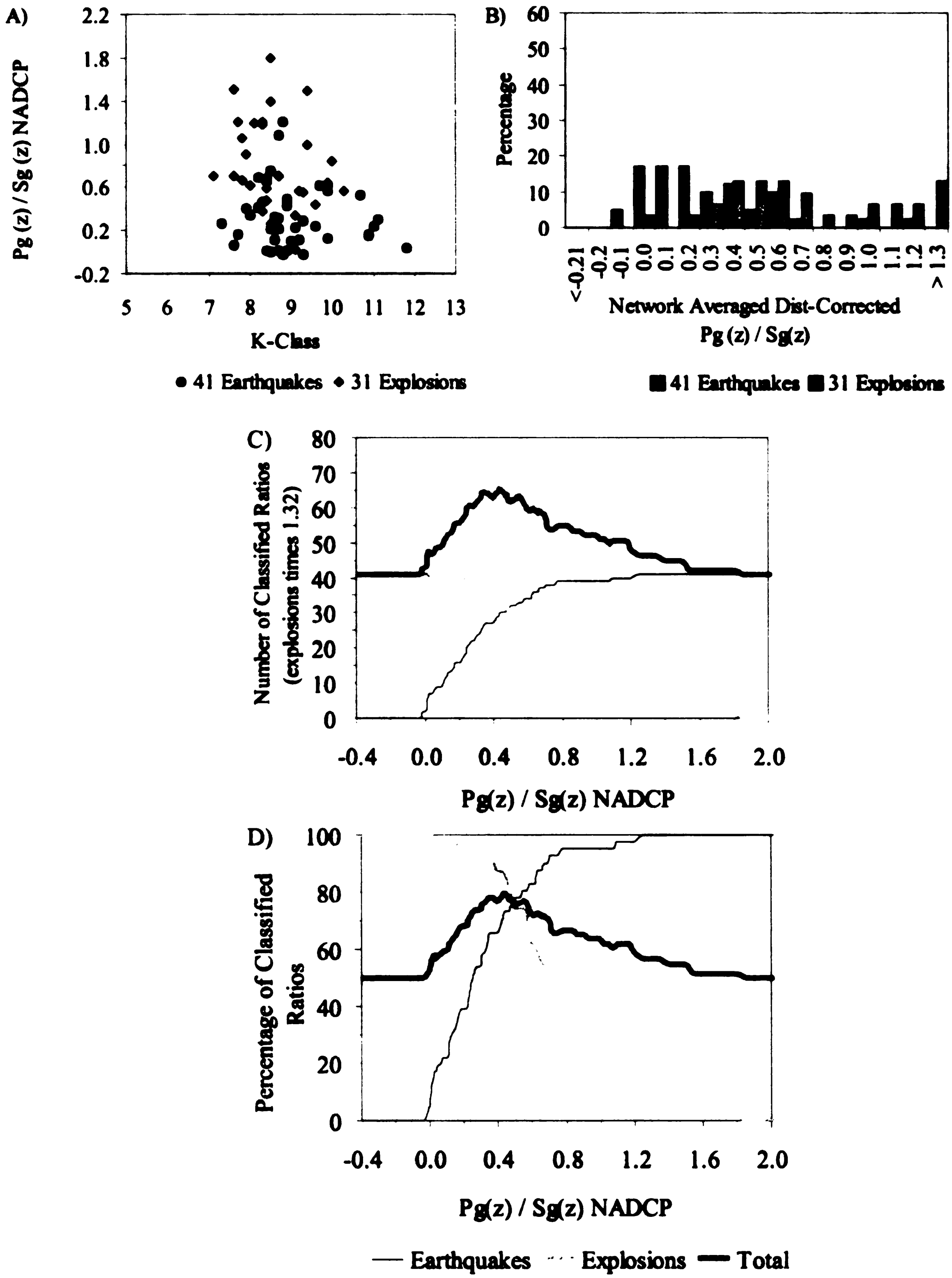


Figure 30. Pg(z)/Sg(z) NADCP ratio for the Southern Yakutia Region. A) Pg(z)/Sg(z) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

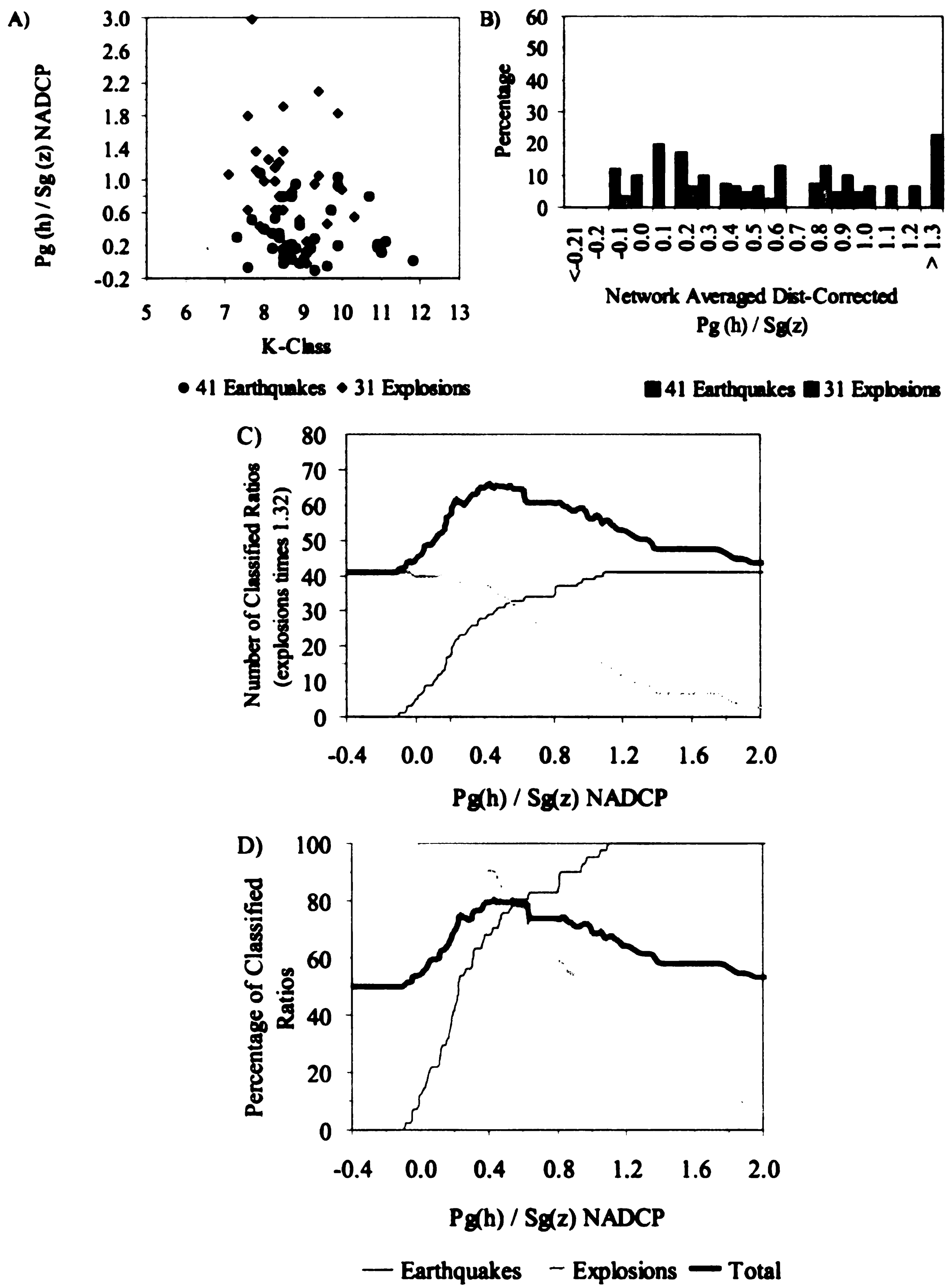


Figure 31. Pg(h)/Sg(z) NADCP ratio for the Southern Yakutia Region. A) Pg(h)/Sg(z) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

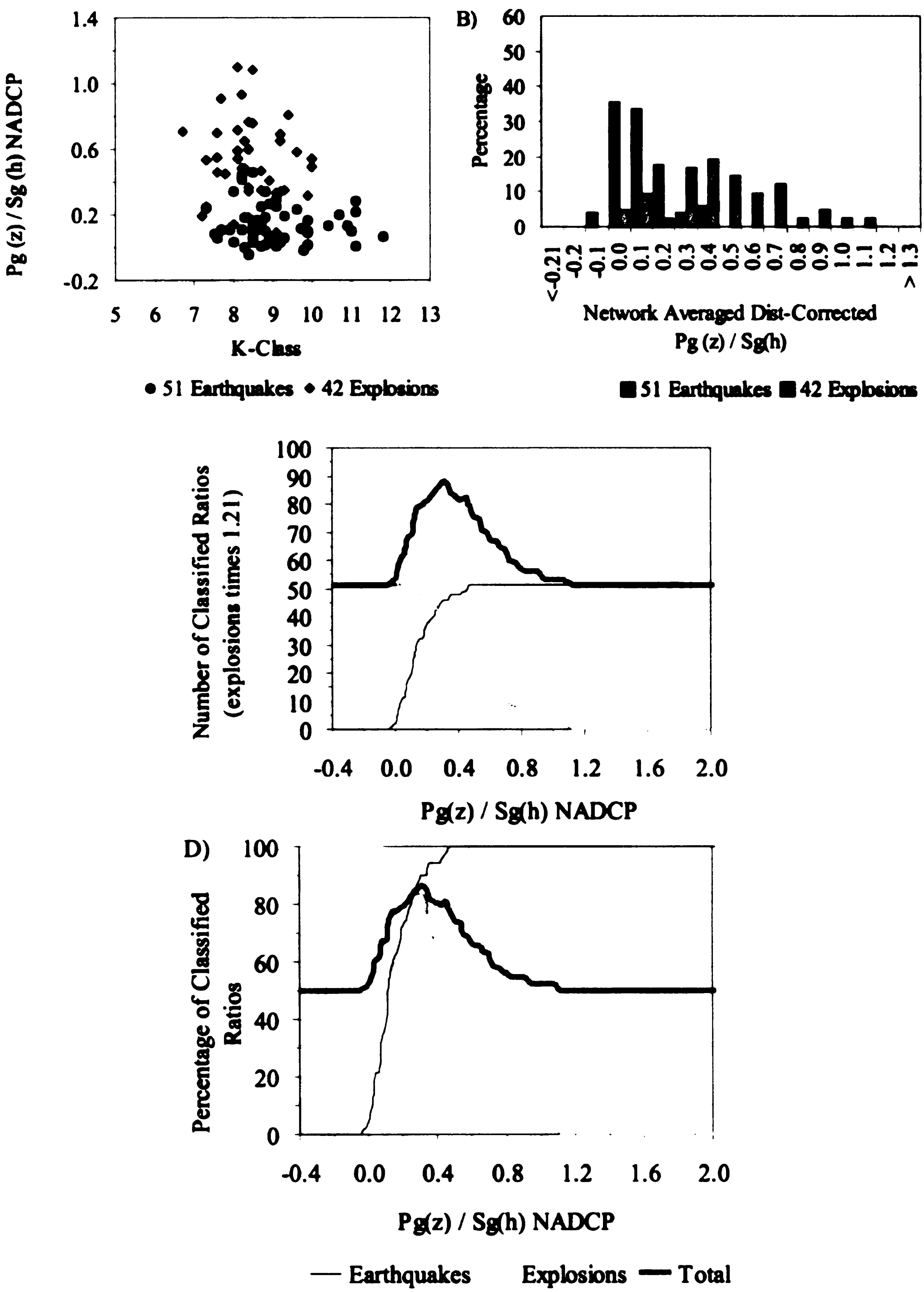


Figure 32. Pg(z)/Sg(h) NADCP ratio for the Southern Yakutia Region. A) Pg(z)/Sg(h) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

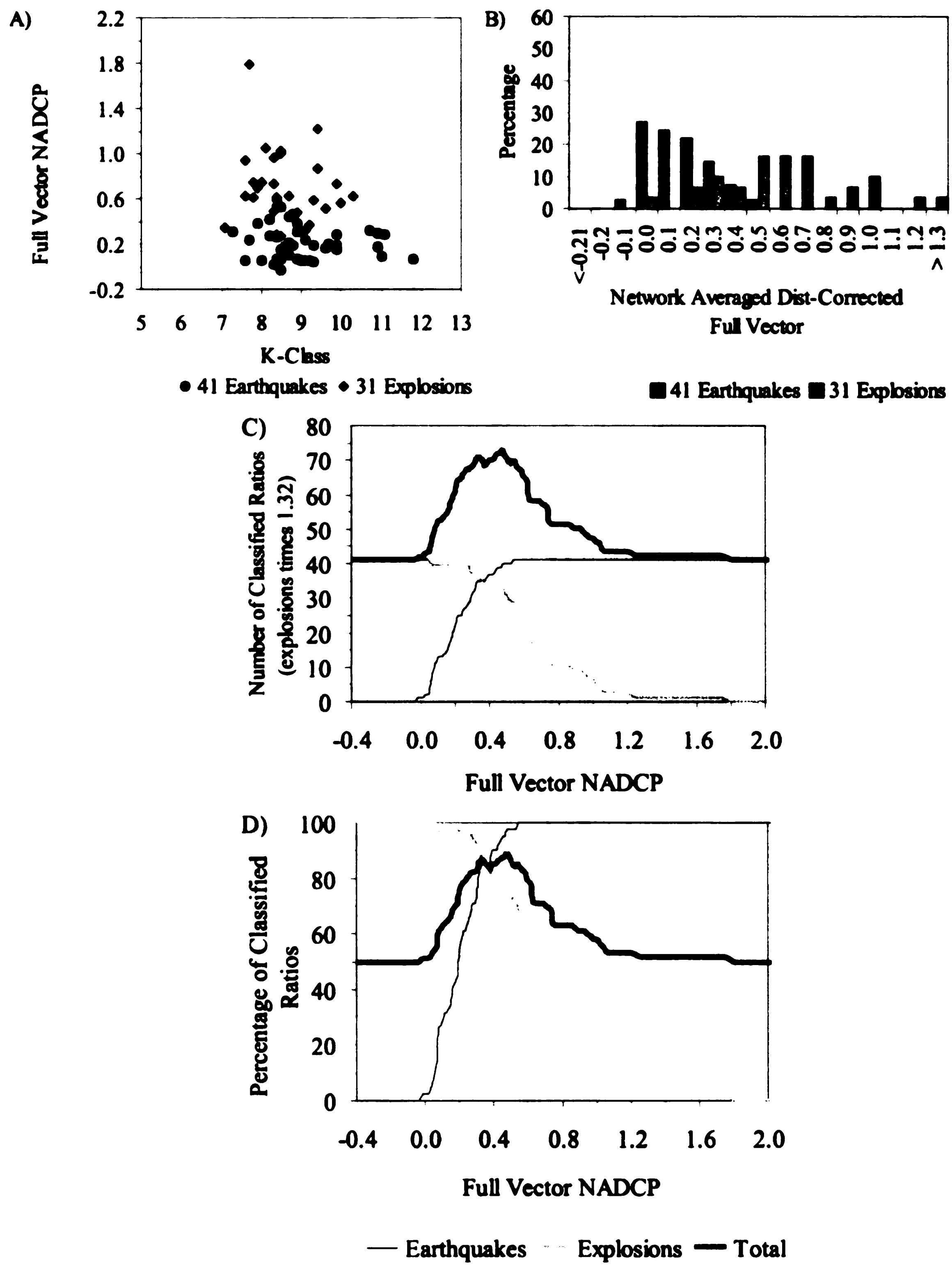


Figure 33. Full vector NADCP ratio for the Southern Yakutia Region. A) Full vector NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

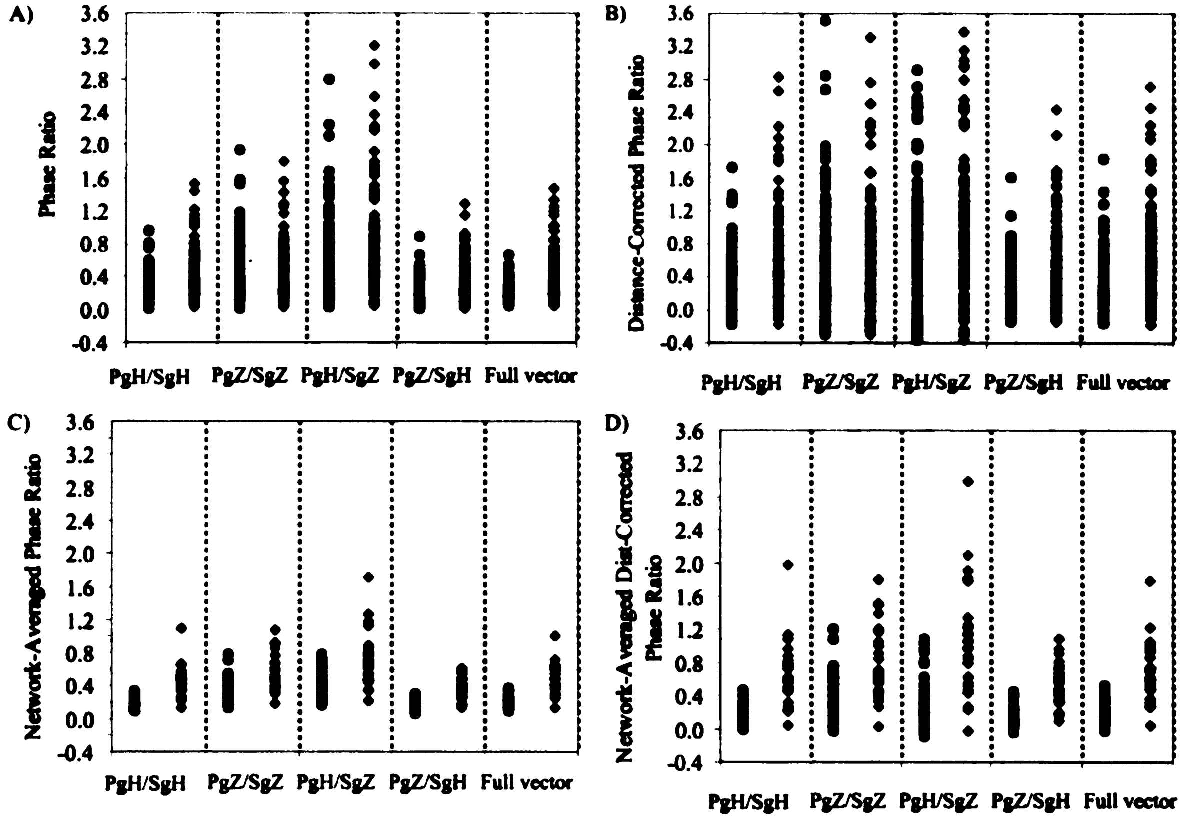


Figure 34. Comparison of the amplitude ratios for the Southern Yakutia region. A) Raw phase ratio. B) DCP ratio. C) NAP ratio. D) NADCP ratio.

Table 8. Distance linear regression results of amplitude phase ratios calculated from earthquakes in the Southern Yakutia region

Phase Ratio	Slope	Y-intercept	R^2	Figure Reference
$\frac{Pg(h)}{Sg(h)}$	-0.0001	0.2326	0.0178	Fig 19a
$\frac{Pg(z)}{Sg(z)}$	-0.0003	0.3985	0.0294	Fig 20a
$\frac{Pg(h)}{Sg(z)}$	-0.0003	0.5055	0.0161	Fig 21a
$\frac{Pg(z)}{Sg(h)}$	-0.0001	0.1971	0.0214	Fig 22a
Full vector	-0.0002	0.2661	0.0305	Fig 23a

R^2 is the coefficient of determination. Values for R^2 near 0 indicate a weak ratio vs. distance trend, while values approaching to one indicate a strong ratio vs. distance dependence.

The critical values found for the discriminants applied to the Southern Yakutia region are shown in Table 10 and in Figure 36. For earthquake-explosion discrimination purposes, an amplitude phase ratio that is lower than the critical value is likely to be an earthquake while an amplitude phase ratio that is higher than the critical value is likely to be an explosion.

Table 11 grades each discriminant tested as good, fair, and poor. The best earthquake-explosion discriminants found for the Southern Yakutia region are the full vector and the Pg(h)/Sg(h) NADCP ratios (Figs. 29 and 33) and the Pg(h)/Sg(h) NAP ratio (Fig. 24). These three discriminants were able to correctly classify as much as 89.1% of the ratios calculated. Other discriminants that produced good separations were the Pg(z)/Sg(h) NADCP ratio (Fig. 32) and also the Pg(z)/Sg(h) (Fig. 27) and the full vector (Fig. 28) NAP ratios.

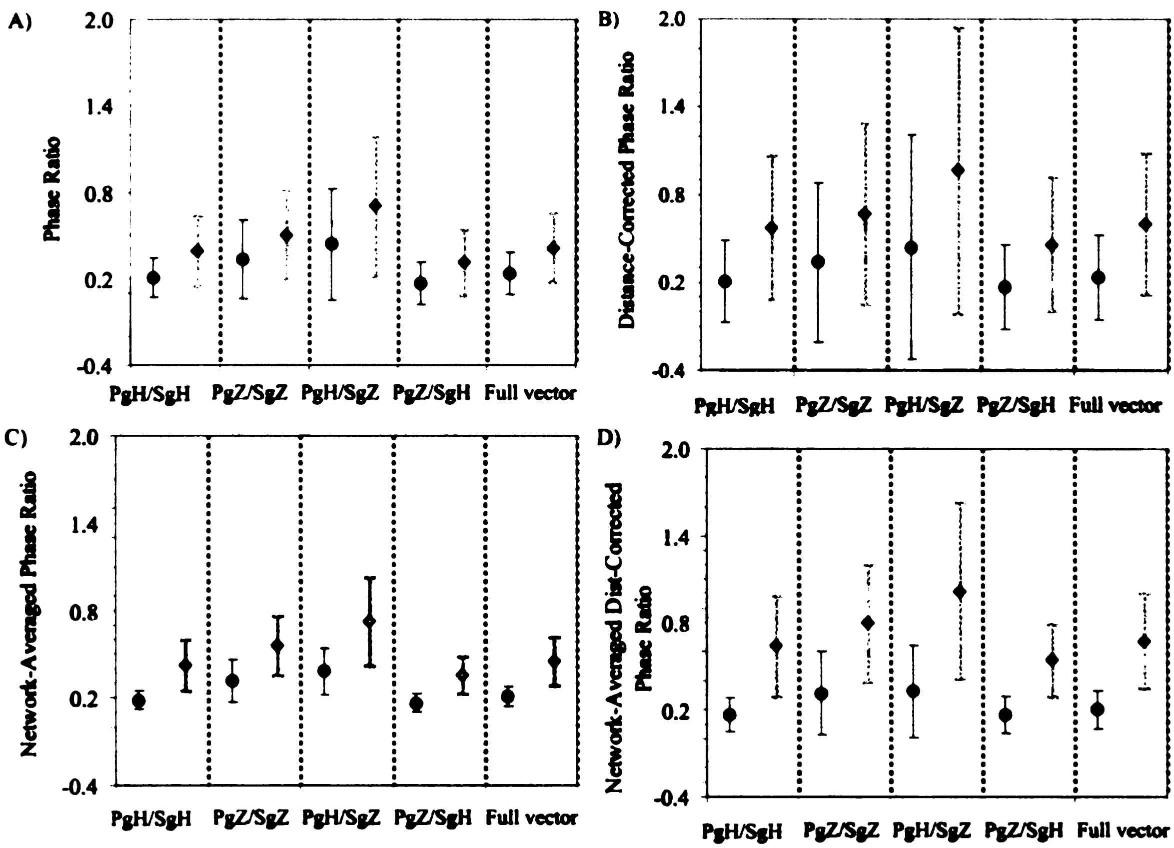


Figure 35. Comparison of amplitude ratios averages and standard deviations in the Southern Yakutia region. The average value is plotted with their arms representing the scatter in red for earthquakes and gray for explosions. A) Raw phase ratio. B) DCP ratio. C) NAP ratio. D) NADCP ratio.

Table 9. Average, standard deviation, and maximum and minimum values obtained for the amplitude ratios in the Southern Yakutia region

Type of technique applied	Type of ratio	Type of event	Number of ratios	Average	σ	Max.	Min.
Raw Phase Ratio	Pg(h)/Sg(h)	Earthquakes	259	0.21	0.14	0.96	0.02
		Explosions	206	0.39	0.24	1.52	0.03
	Pg(z)/Sg(z)	Earthquakes	259	0.34	0.27	1.93	0.02
		Explosions	206	0.50	0.31	1.80	0.03
	Pg(h)/Sg(z)	Earthquakes	259	0.44	0.39	2.79	0.03
		Explosions	206	0.70	0.49	3.20	0.05
	Pg(z)/Sg(h)	Earthquakes	323	0.17	0.14	1.40	0.02
		Explosions	251	0.31	0.23	1.29	0.00
	Full vector	Earthquakes	259	0.23	0.15	1.02	0.04
		Explosions	206	0.42	0.24	1.47	0.04
Distance-Corrected Phase (DCP) Ratio	Pg(h)/Sg(h)	Earthquakes	259	0.21	0.28	1.73	-0.17
		Explosions	206	0.57	0.49	2.83	-0.17
	Pg(z)/Sg(z)	Earthquakes	259	0.34	0.54	3.52	-0.29
		Explosions	206	0.67	0.62	3.31	-0.30
	Pg(h)/Sg(z)	Earthquakes	259	0.44	0.77	5.14	-0.37
		Explosions	206	0.97	0.98	5.98	-0.37
	Pg(z)/Sg(h)	Earthquakes	323	0.17	0.29	2.63	-0.15
		Explosions	251	0.46	0.46	2.43	-0.20
	Full vector	Earthquakes	259	0.23	0.29	1.83	-0.16
		Explosions	206	0.60	0.48	2.70	-0.18
Network-Averaged Phase (NAP) Ratio	Pg(h)/Sg(h)	Earthquakes	41	0.19	0.06	0.34	0.10
		Explosions	31	0.42	0.17	1.09	0.13
	Pg(z)/Sg(z)	Earthquakes	41	0.32	0.15	0.79	0.13
		Explosions	31	0.56	0.20	1.07	0.18
	Pg(h)/Sg(z)	Earthquakes	41	0.38	0.16	0.78	0.17
		Explosions	31	0.73	0.30	1.71	0.22
	Pg(z)/Sg(h)	Earthquakes	51	0.15	0.06	0.31	0.06
		Explosions	42	0.34	0.12	0.63	0.12
	Full vector	Earthquakes	41	0.22	0.07	0.38	0.10
		Explosions	31	0.45	0.16	1.01	0.14
Network-Averaged Distance-Corrected Phase (NADCP) Ratio	Pg(h)/Sg(h)	Earthquakes	41	0.17	0.12	0.48	-0.01
		Explosions	31	0.64	0.35	1.98	0.05
	Pg(z)/Sg(z)	Earthquakes	41	0.32	0.29	1.21	-0.03
		Explosions	31	0.80	0.41	1.80	0.02
	Pg(h)/Sg(z)	Earthquakes	41	0.33	0.32	1.09	-0.10
		Explosions	31	1.02	0.61	2.99	-0.02
	Pg(z)/Sg(h)	Earthquakes	51	0.14	0.12	0.46	-0.04
		Explosions	42	0.54	0.25	1.10	0.09
	Full vector	Earthquakes	41	0.20	0.13	0.53	-0.03
		Explosions	31	0.68	0.33	1.79	0.05

σ is the standard deviation of the group of amplitude ratios.

Table 10. Critical values for the Southern Yakutia region

Discrimant	Raw Phase Ratio	DCP Ratio	NAP Ratio	NADCP Ratio
$\frac{Pg(h)}{Sg(h)}$	0.25	0.29	0.32-0.33	0.41-0.46
$\frac{Pg(z)}{Sg(z)}$	0.31	0.32	0.44	0.44
$\frac{Pg(h)}{Sg(z)}$	0.41	0.36	0.45	0.55
$\frac{Pg(z)}{Sg(h)}$	0.20	0.23	0.24	0.30-0.32
Full vector	0.31	0.38	0.35	0.48

Table 11. Maximum percentage of correctly classified events and qualitative performance assignment for each discriminant in the Southern Yakutia region

Discrimant	Raw Phase Ratio	DCP Ratio	NAP Ratio	NADCP Ratio
$\frac{Pg(h)}{Sg(h)}$	Poor 71.3%	Poor 71.0%	Good 89.1%	Good 89.1%
$\frac{Pg(z)}{Sg(z)}$	Poor 65.4%	Poor 66.6%	Fair 78.5%	Fair 80.1%
$\frac{Pg(h)}{Sg(z)}$	Poor 69.4%	Poor 69.4%	Fair 81.3%	Fair 80.6%
$\frac{Pg(z)}{Sg(h)}$	Poor 68.0%	Poor 68.6%	Good 86.8%	Good 86.8%
Full Vector	Poor 71.2%	Poor 71.6%	Good 87.9%	Good 89.1%

As seen in Figure 36, the critical value usually did not separate an equal number of earthquake and explosions. For example, Pg(h)/Sg(h) NADCP ratios correctly classified 89.1% of the ratios calculated, separating 97.6% of the earthquakes and 80.6% of the explosions (Fig. 36d). On the other hand, other amplitude ratios separated the two groups of events equally, such as the Pg(h)/Sg(z) NADCP ratios that separated 80.6% of the earthquakes and 80.5% of the explosions (Fig. 36d). There was not a clear pattern that could be observed in the way that the amplitude ratios separated earthquakes and explosions.

As expected from the weak phase ratio vs. distance dependence observed for this region, the distance correction did not have a significant effect on the performance of the phase ratios after its application. The percentage of correctly classified events by the amplitude ratios changed only by -0.3 to 1.2%, slightly improving the performance of the Pg(z)/Sg(z), Pg(z)/Sg(h), and the full vector phase ratios (Table 11). The critical values were also slightly affected by the distance correction. With the exception of the Pg(h)/Sg(z) ratio, critical values always increased after the application of the distance correction (Table 10).

More importantly, averaging the ratios over the network had a considerable effect on the performance of discriminants. The percentage of correctly classified events increased by 11.9 to 18.2% after averaging. The Pg(h)/Sg(h) and Pg(z)/Sg(h) NAP ratios had the largest change, followed by the full vector NAP ratios. The critical values also increased in all cases, as seen in Table 10. The NADCP ratios also significantly improved the performance. The critical values also increased in all cases with respect to the ratios before averaging (Table 10).

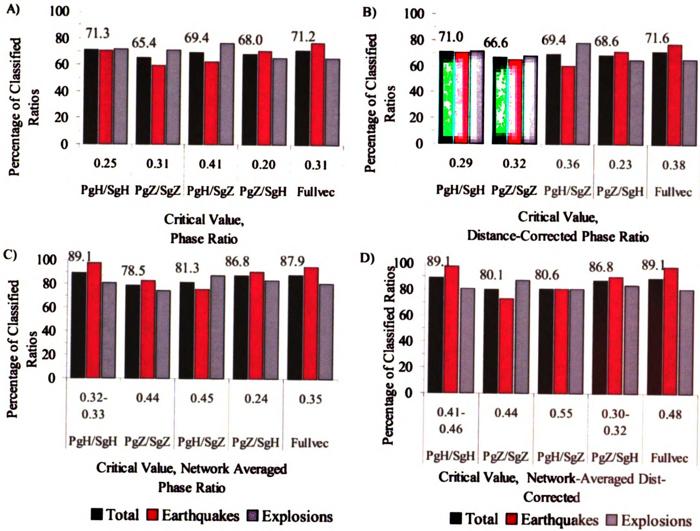


Figure 36. Comparison of performance of the amplitude ratios in the Southern Yakutia region. A) Raw phase ratio. B) DCP ratio. C) NAP ratio. D) NADCP ratio.

2.3.2. Phase Ratios for Individual Stations

DCP ratios were analyzed separately for individual stations that had more than ten amplitude phase ratios for both earthquakes and explosions. In the Southern Yakutia region, only CGD, CLNS, TUG, USZ, and UURS fulfilled this requirement (Fig. 13e).

The critical values, averages, and standard deviations found for each station were extremely variable, as seen in Table 12. The DCP ratios that performed the best were Pg(h)/Sg(h) for the CGD and CLNS, Pg(z)/Sg(h) for the TUG and UURS, and the full vector for the USZ station (Fig. 37, Appendix B). In general, the best separations were found in ratios calculated from amplitudes recorded at TUG, USZ, and UURS (Table 12). The Pg(z)/Sg(h) DCP ratio calculated from station TUG showed the best performance of all the amplitude ratios obtained from data recorded at individual stations. This DCP ratio was able to correctly classify 83.6% of the data used. This percentage was particularly high when compared to the performance of the Pg(z)/Sg(h) DCP on the whole region (69.0%).

One interesting situation occurred at stations USZ and UURS, where all amplitude ratios performed similarly (70.1-76.4%). As seen in the previous section, Pg(z)/Sg(z) and Pg(h)/Sg(z) always performed poorly and very differently from the rest of the amplitude ratios (Table 11). On the other hand, stations CGD and CLNS performed poorly for all amplitude rations with the exception of the Pg(h)/Sg(h) DCP ratio, as shown in Table 12.

Table 12. Critical values, performances, and averages of DCP calculated for individual stations in the Southern Yakutia region

Station	# [1]	# [2]		**Pg(h)/Sg(h)**	**Pg(z)/Sg(z)**	**Pg(h)/Sg(z)**	**Pg(z)/Sg(h)**	**Full Vector**
CGD	32	41	Performance (%)	Poor (70.3%)	Poor (58.0%)	Poor (63.3%)	Poor (59.4%)	Poor (69.8%)
			Critical Value	0.36	0.22-0.25	0.75-0.81	0.10	0.36
			Average earthquake (σ)	0.24 (0.24)	0.53 (0.72)	0.98 (1.16)	0.10 (0.14)	0.26 (0.25)
			Average explosion (σ)	0.41 (0.26)	0.46 (0.41)	1.33 (1.22)	0.16 (0.23)	0.41 (0.27)
CLNS	36	28	Performance (%)	Poor (74.6%)	Poor (57.8%)	Poor (67.6%)	Poor (60.7%)	Poor (64.4%)
			Critical Value	0.19	0.30-0.33	0.21-0.27	0.30	0.21-0.22
			Average earthquake (σ)	0.12 (0.22)	0.46 (0.59)	0.25 (0.42)	0.20 (0.26)	0.21 (0.27)
			Average explosion (σ)	0.33 (0.29)	0.54 (0.65)	0.62 (0.75)	0.33 (0.41)	0.40 (0.37)
TUG	38	41	Performance (%)	Fair (76.3%)	Poor (69.7%)	Poor (64.7%)	Fair (83.6%)	Fair (78.7%)
			Critical Value	0.45	0.51-0.54	0.14	0.23-0.24	0.50
			Average earthquake (σ)	0.27 (0.31)	0.38 (0.52)	0.77 (0.96)	0.12 (0.18)	0.28 (0.33)
			Average explosion (σ)	0.76 (0.58)	0.76 (0.51)	1.06 (1.15)	0.60 (0.39)	0.77 (0.52)
USZ	81	52	Performance (%)	Fair (75.6%)	Fair (72.7%)	Fair (75.6%)	Fair (74.6%)	Fair (76.1%)
			Critical Value	0.29	0.32	0.42	0.39	0.38-0.39
			Average earthquake (σ)	0.21 (0.25)	0.25 (0.45)	0.30 (0.50)	0.17 (0.22)	0.23 (0.26)
			Average explosion (σ)	0.71 (0.55)	0.87 (0.79)	1.08 (2.35)	0.58 (0.51)	0.76 (0.57)
UURS	45	40	Performance (%)	Poor (70.1%)	Poor (74.2%)	Fair (75.4%)	Fair (76.4%)	Fair (74.8%)
			Critical Value	0.13-0.14	0.26	0.28	0.24-0.25	0.37
			Average earthquake (σ)	0.22 (0.30)	0.16 (0.28)	0.25 (0.65)	0.19 (0.26)	0.20 (0.23)
			Average explosion (σ)	0.55 (0.47)	0.65 (0.54)	0.67 (0.53)	0.53 (0.49)	0.57 (0.42)

[1] number of ratios from earthquakes, [2] number of ratios from explosions, σ standard deviation of the group of amplitude ratios

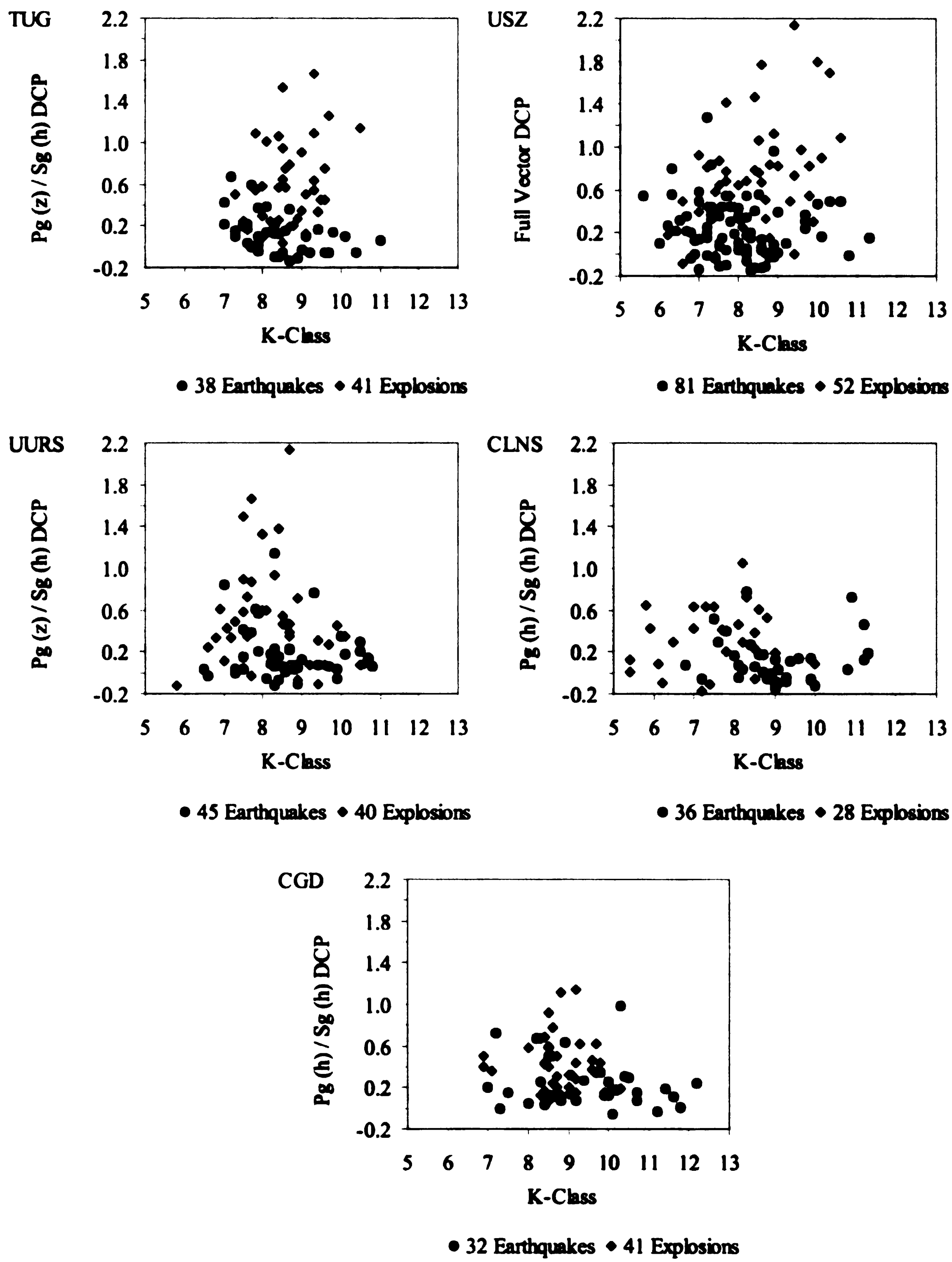


Figure 37. Best discriminants for individual stations in the Southern Yakutia region. The totality of the plots per station is shown in Appendix B.

2.4. Magadan and Northern Yakutia

Amplitude information from 90 earthquakes (6.1 < K < 12.8, 16 < Δ < 916 km) and 130 explosions (4.8 < K < 10.2, 9 < Δ < 752 km) in the Magadan and Northern Yakutia regions was used to create 370 Pg(z)/Sg(h) phase ratios from earthquakes and 220 from explosions, and 255 phase ratios of the other four types from earthquakes and 138 from explosions (Table 5). The distribution of the amplitude ratios by time, K class, epicentral distance, and seismic station of the phase ratios calculated from stations with amplitude information in all components is shown in Figure 38.

In the Magadan and Northern Yakutia regions, the time window used for the selection of explosions was 21:00-8:59 UTC and was 9:00-20:59 for earthquakes (Fig. 38a). The distribution by K class was different for earthquakes and explosions with more earthquakes with a higher K class than explosions. Sixty-five percent of the phase ratios calculated for both earthquakes and explosions came from stations that recorded events with K class of 7.0-9.0 (Fig 38b).

The epicentral distribution of the earthquakes was more scattered than that of explosions. There was a concentration of explosions in the Susuman mining region (coordinates 62.5-64°N and 146-149°E). Approximately 54% of the phase ratios were calculated from explosions located in this particular area. The epicentral distance distribution of explosions was biased by this fact, showing the greatest of the explosions recorded at distances of 200-250 km. The earthquakes showed a more uniform distribution by all of epicentral distances, especially in the range of 100-350 km (Fig. 38c).

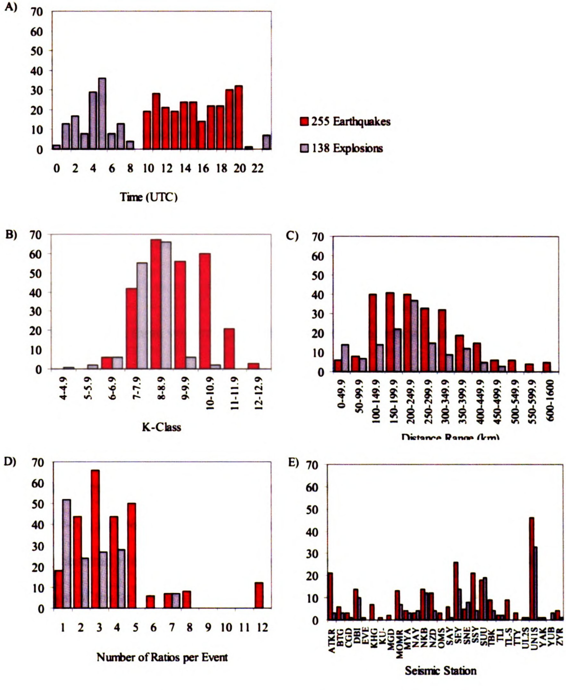


Figure 38. Distribution of phase ratios calculated from amplitude information in all components for the Magadan and Northern Yakutia regions. A) By time. B) By K class. C) By epicentral distance. D) By maximum number of ratios per event. E) By seismic station.

A large number of the explosions (~38%) considered for the Magadan and Northern Yakutia regions had only one station with amplitude information on all components (Fig. 38d). Only 17 explosions and 47 earthquakes had more than three stations with amplitude information on the three components. In the case of the Pg(z)/Sg(h) 65 earthquakes and 24 explosions allowed the averaging over the network following the procedure explained in the methodology. As shown in Figure 38e, most of the phase ratios calculated (~ 55%) came from events recorded at UN1S (~ 21%), SUU (~ 10%), SEY (~ 10%), DBI (~ 6%), and NKB (7%).

2.4.1. Results

Even though there was overlap in the populations of ratios from explosions and earthquakes, there was a clear tendency of the amplitude ratios from explosions to have higher values than earthquakes, as in the Southern Yakutia region.

The results of the five types of amplitude ratios obtained are shown as follows: raw phase ratios in Figures 39 to 43, DCP ratios in Figures 44 to 48, NAP ratios in Figures 49-53, and NADCP phase ratios in Figures 54-58. Each figure describes one specific phase ratio in the same way as was done for the Southern Yakutia region. A comparison of the values of all types of amplitude ratios is shown in Figure 59.

The results of all phase ratio vs. distance regressions used for the Magadan and Northern Yakutia regions are shown in Table 13. The DCP ratios shown in Figures 44c-48c were calculated using these linear regressions. The phase ratio vs. distance dependence was also found to be weak for this region.

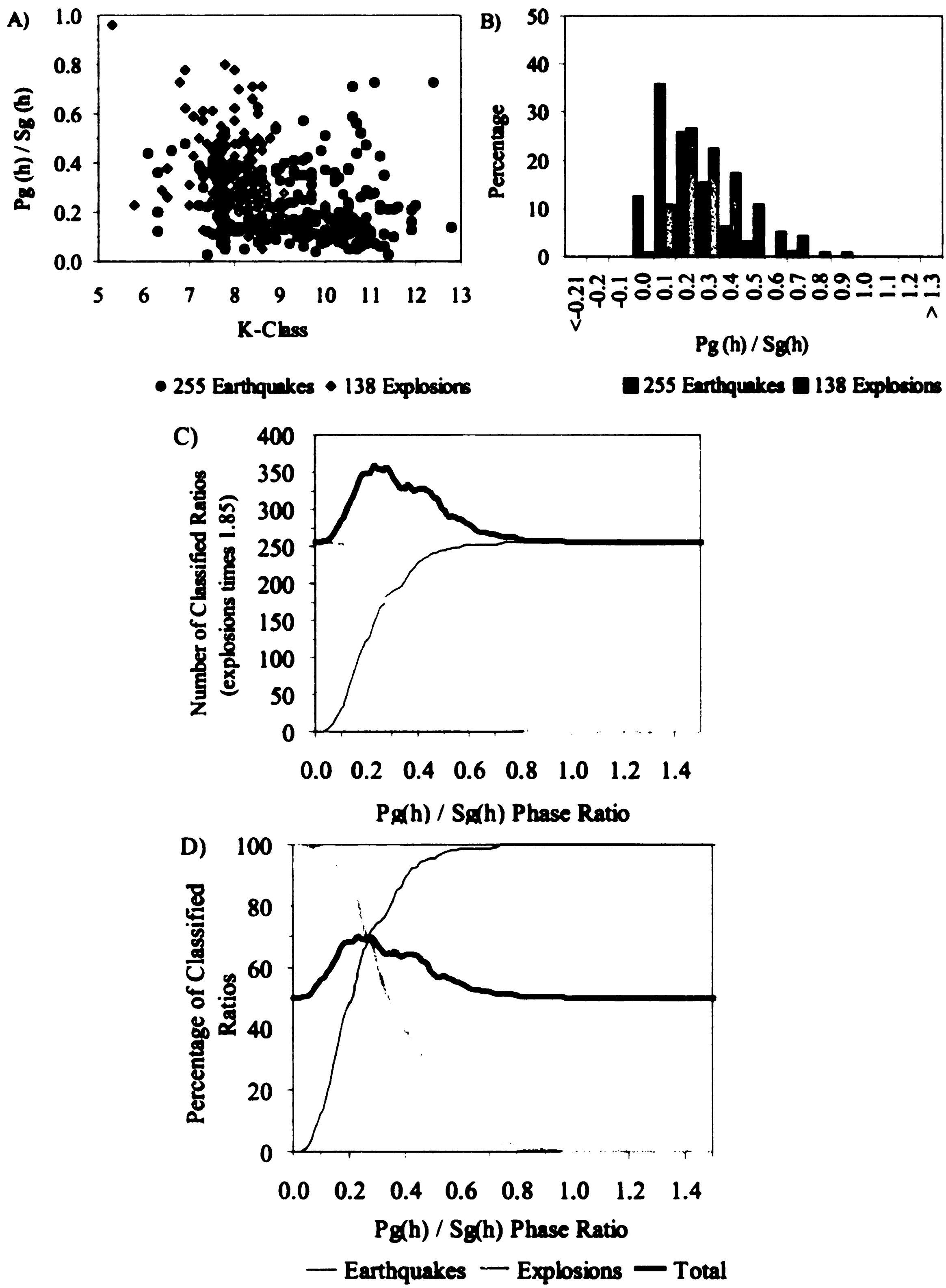


Figure 39. Pg(h)/Sg(h) raw phase ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(h) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

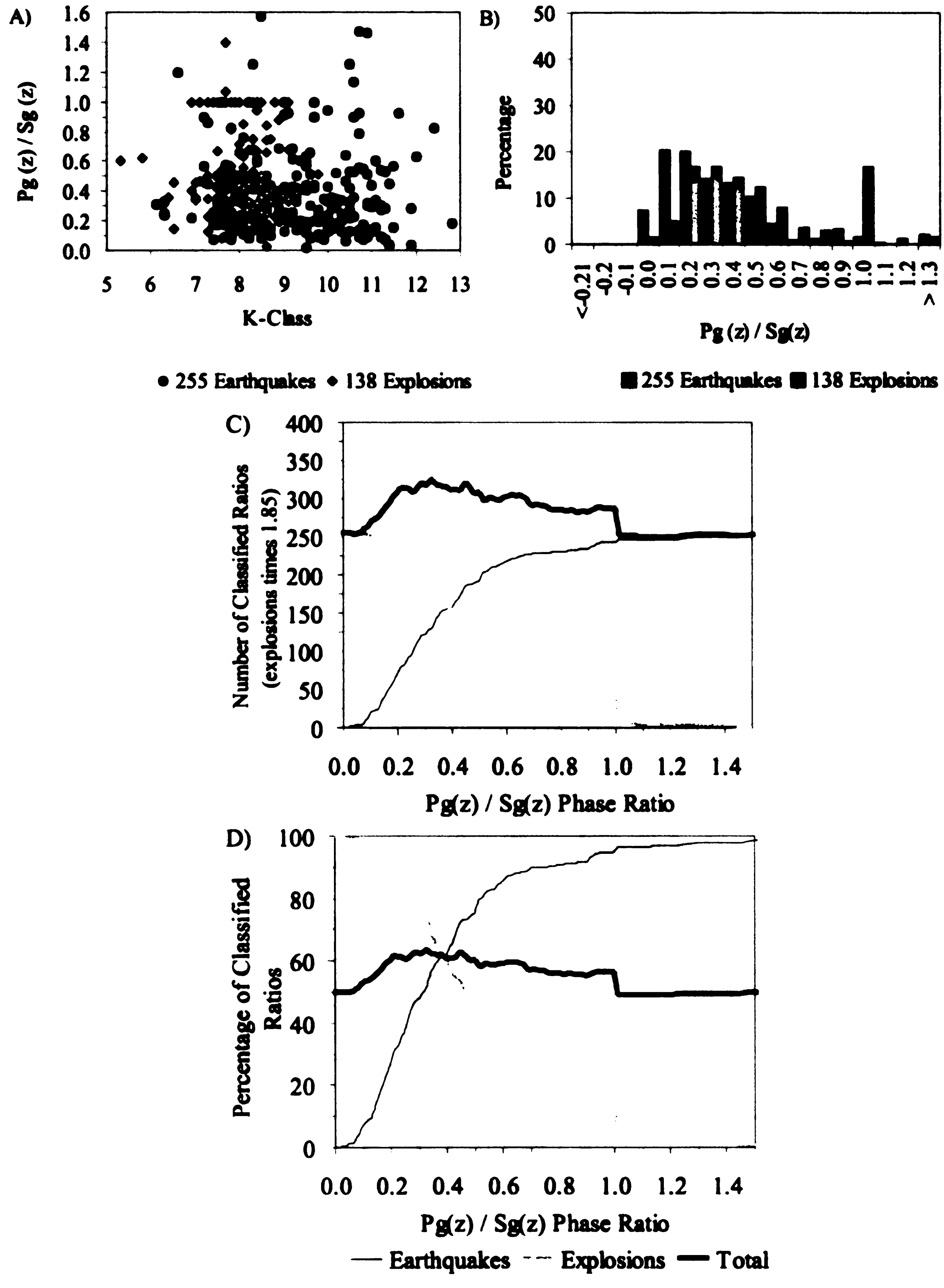


Figure 40. Pg(z)/Sg(z) raw phase ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(z) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

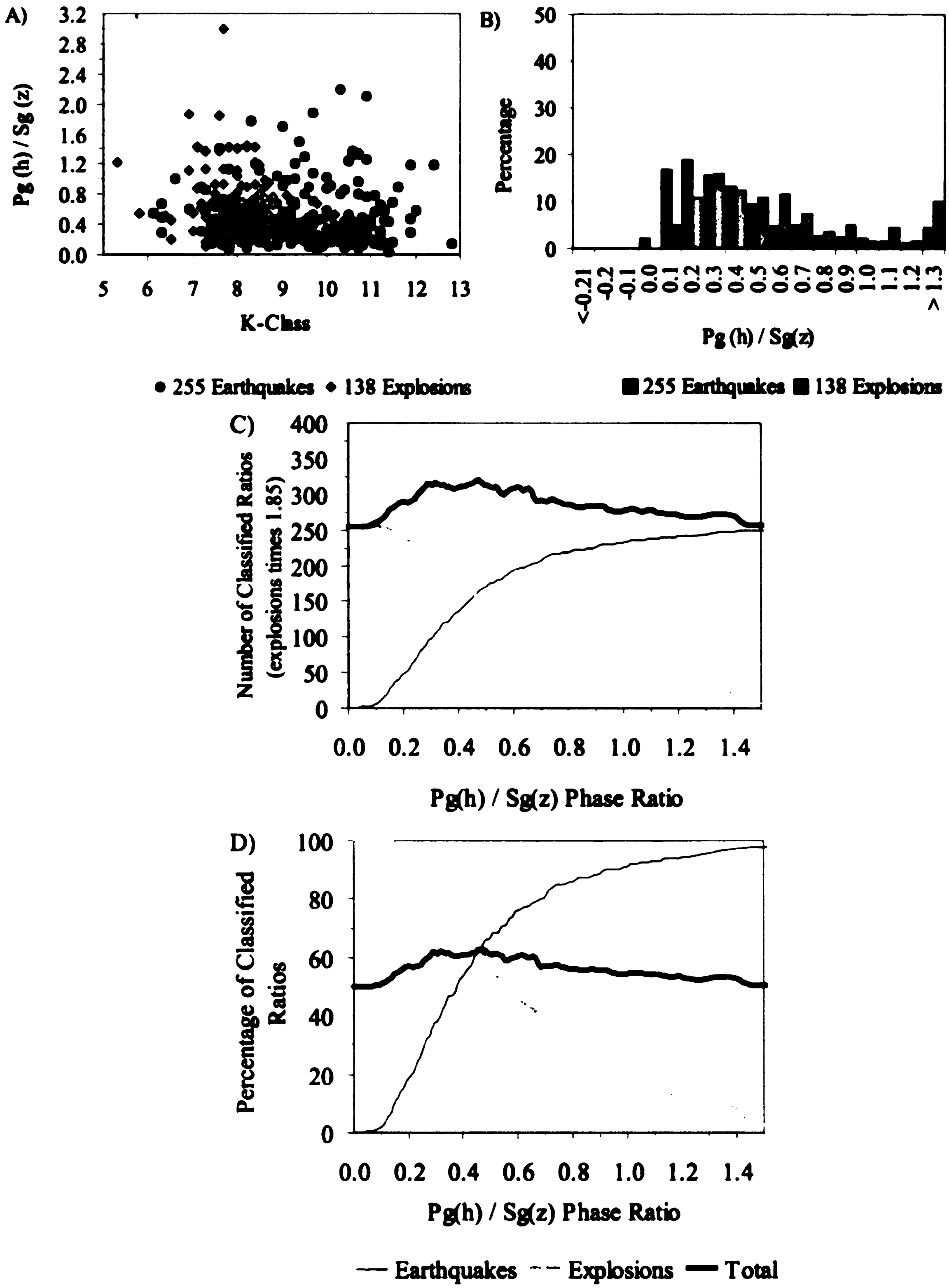


Figure 41. Pg(h)/Sg(z) raw phase ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(z) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

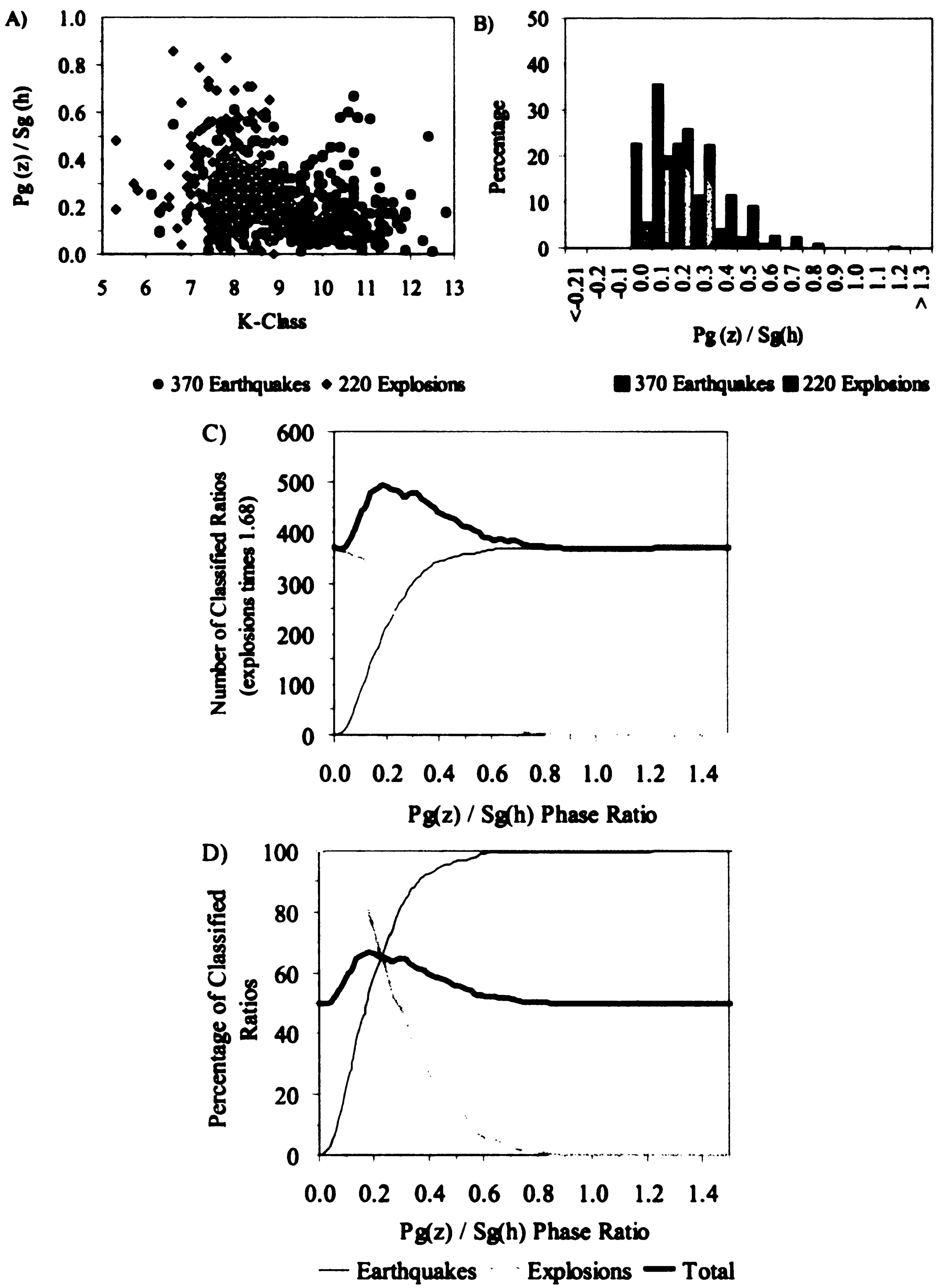


Figure 42. Pg(z)/Sg(h) raw phase ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(h) vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events .

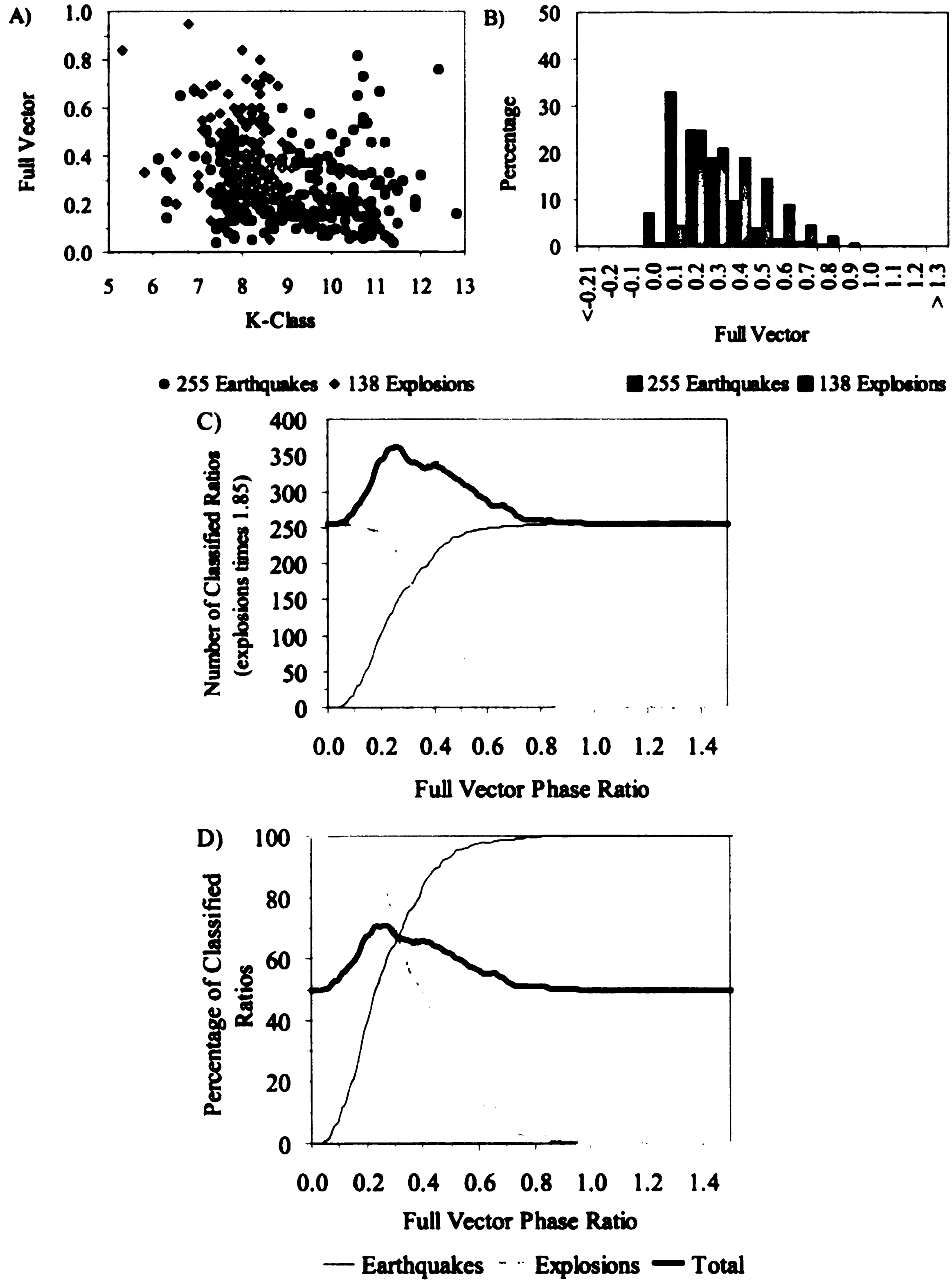


Figure 43. Full vector raw phase ratio for the Magadan and Northern Yakutia regions. A) Full vector vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

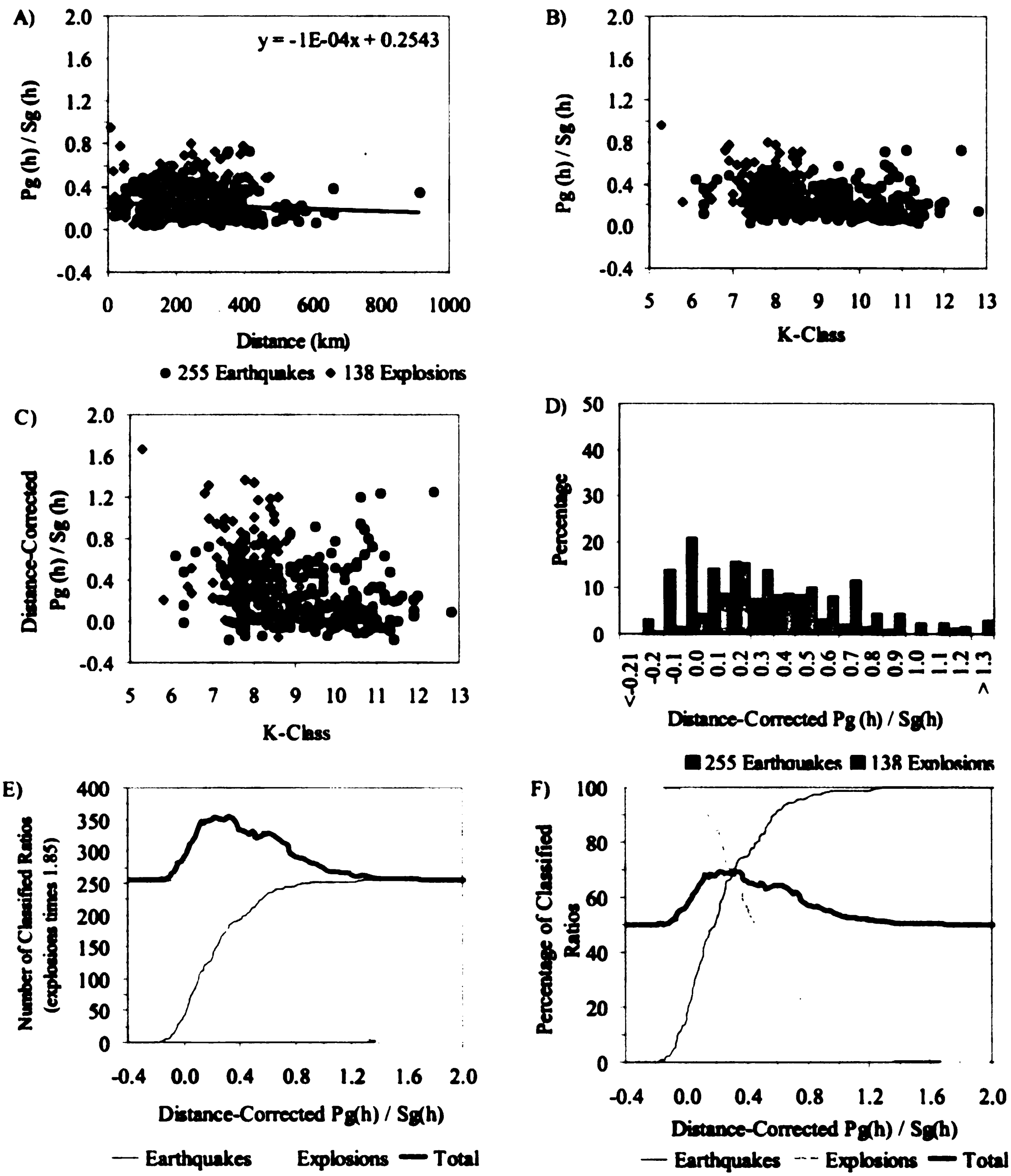


Figure 44. Pg(h)/Sg(h) DCP ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(h) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(h)/Sg(h) phase ratio vs. K class. C) Pg(h)/Sg(h) DCP ratio vs. K class. D). Histogram of the Pg(h)/Sg(h) DCP ratio. E) Number of correctly classified events. F) Percentage of correctly classified events.

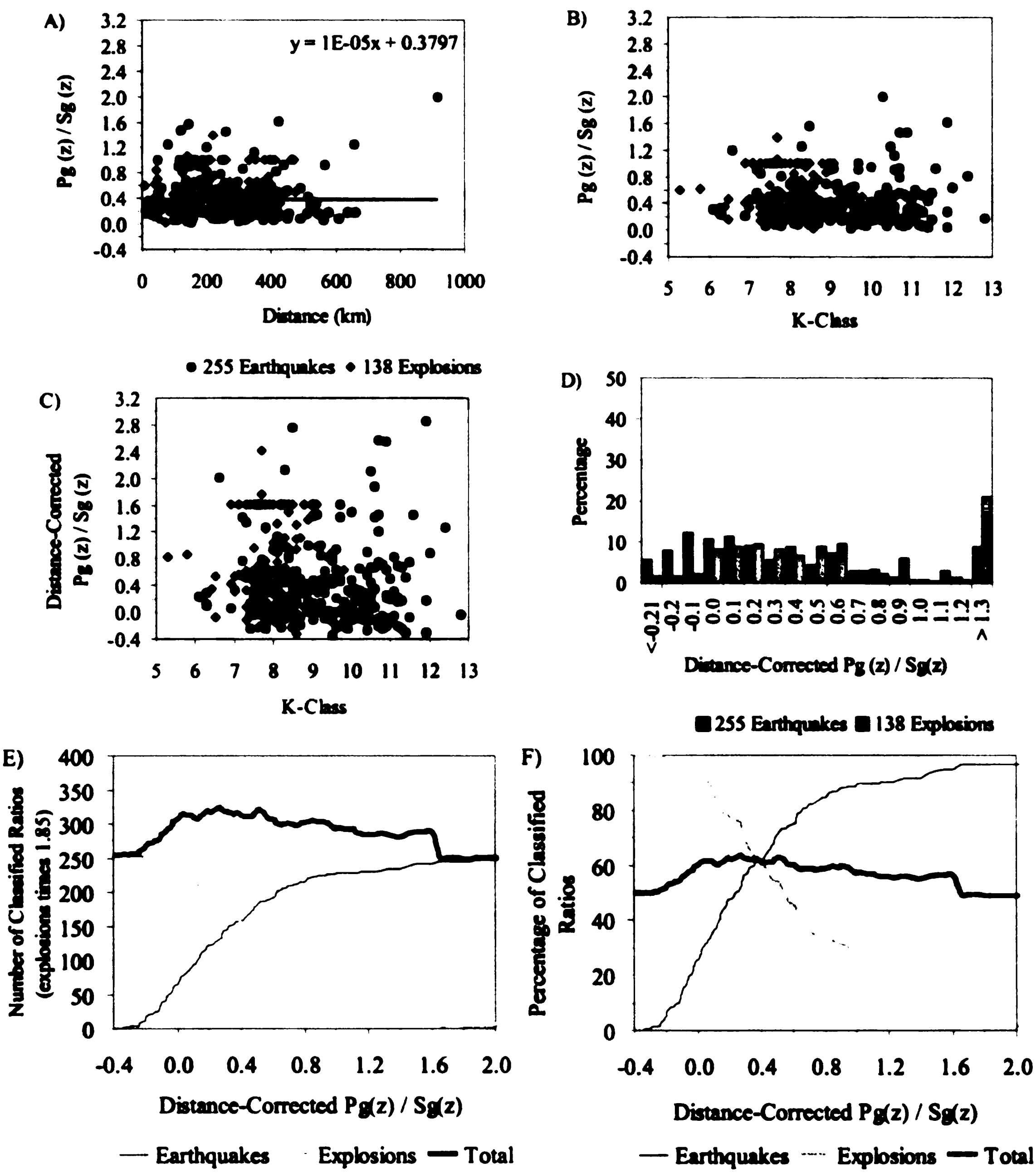


Figure 45. Pg(z)/Sg(z) DCP ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(z) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(z)/Sg(z) phase ratio vs. K class. C) Pg(z)/Sg(z) DCP ratio vs. K class. D). Histogram of the Pg(z)/Sg(z) DCP ratio. E) Number of correctly classified events. F) Percentage of correctly classified events.

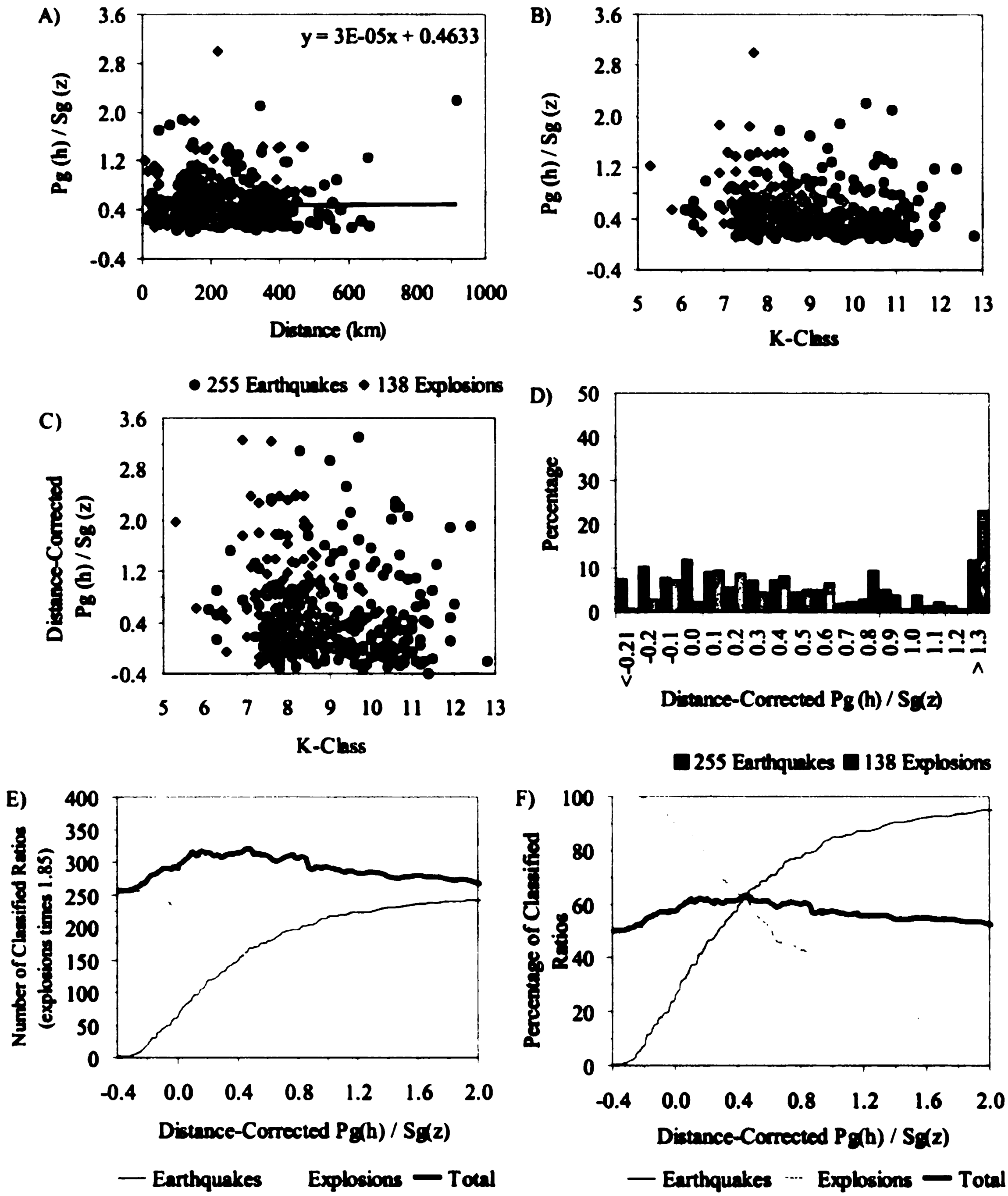


Figure 46. Pg(h)/Sg(z) DCP ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(z) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(h)/Sg(z) phase ratio vs. K class. C) Pg(h)/Sg(z) DCP ratio vs. K class. D). Histogram of the Pg(h)/Sg(z) DCP ratio. E) Number of correctly classified events. F) Percentage of correctly classified events.

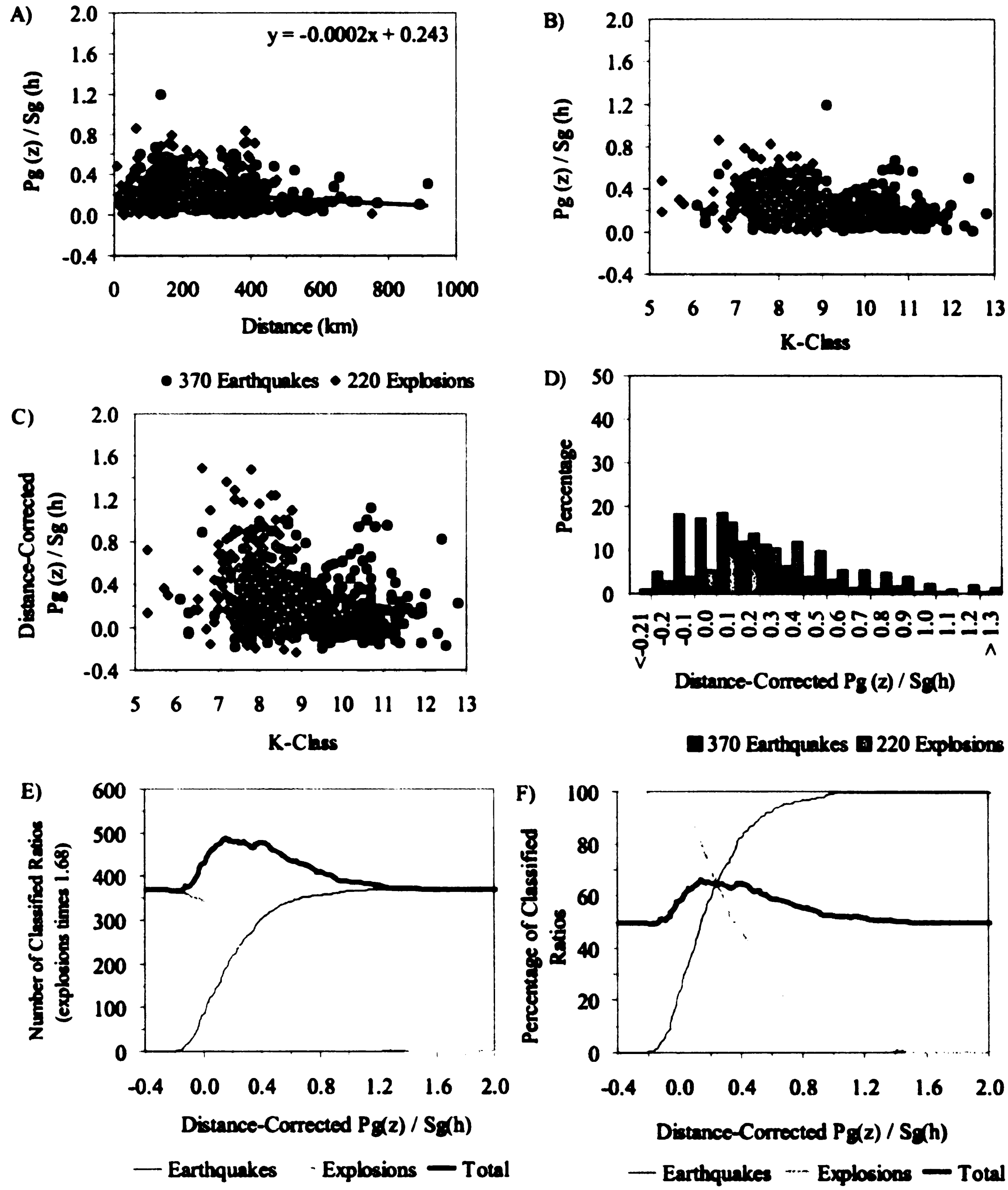


Figure 47. Pg(z)/Sg(h) DCP ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(h) phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Pg(z)/Sg(h) phase ratio vs. K class. C) Pg(z)/Sg(h) DCP ratio vs. K class. D). Histogram of the Pg(z)/Sg(h) DCP ratio. E) Number of correctly classified events. F) Percentage of correctly classified events.

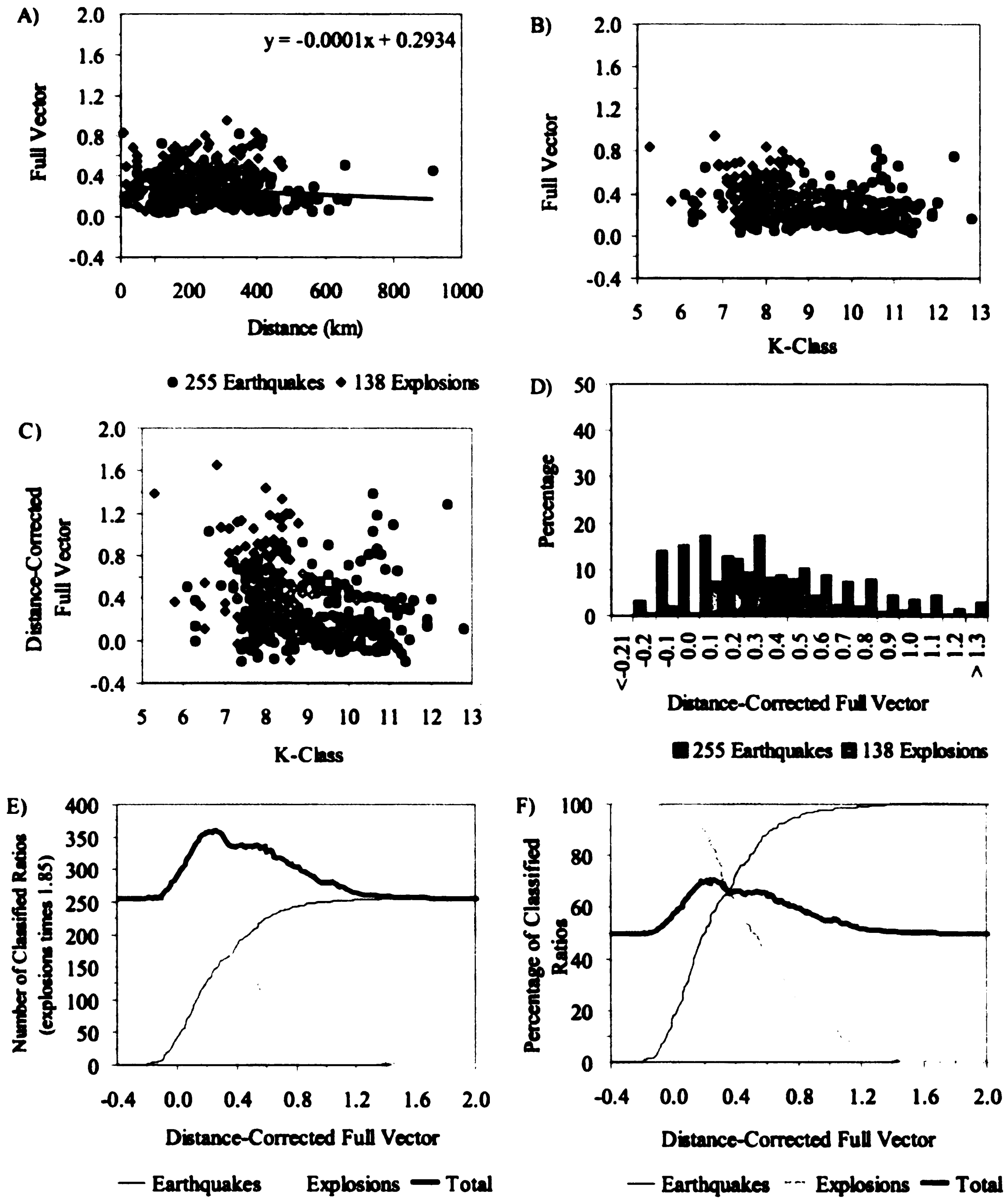


Figure 48. Full vector DCP ratio for the Magadan and Northern Yakutia regions. A) Full vector phase ratio vs. epicentral distance and linear regression for the earthquake data. B) Full vector phase ratio vs. K class. C) Full vector DCP ratio vs. K class. D). Histogram of the Full vector DCP ratio. E) Number of correctly classified events. F) Percentage of correctly classified events.

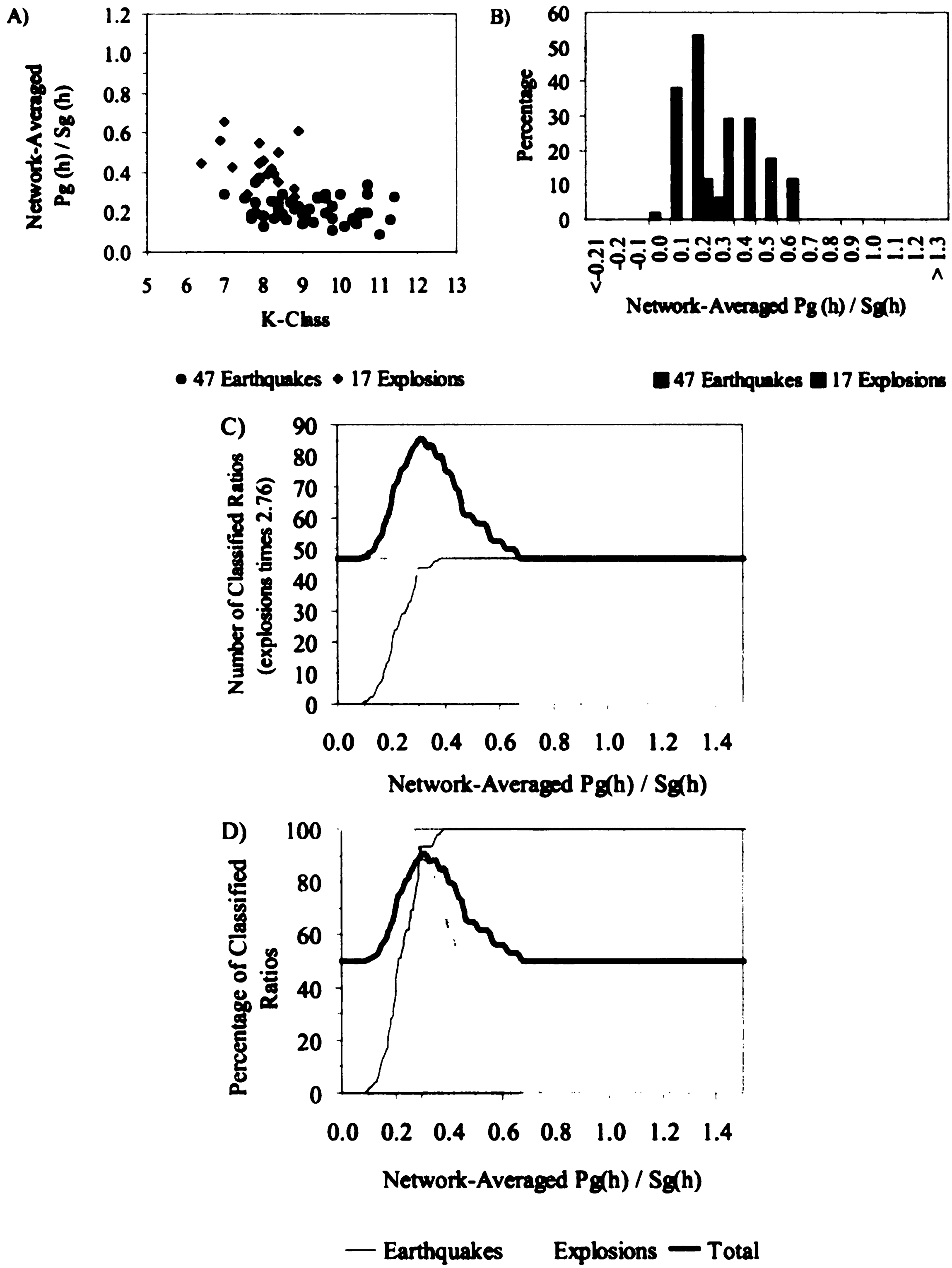


Figure 49. NAP Pg(h)/Sg(h) NAP ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(h) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

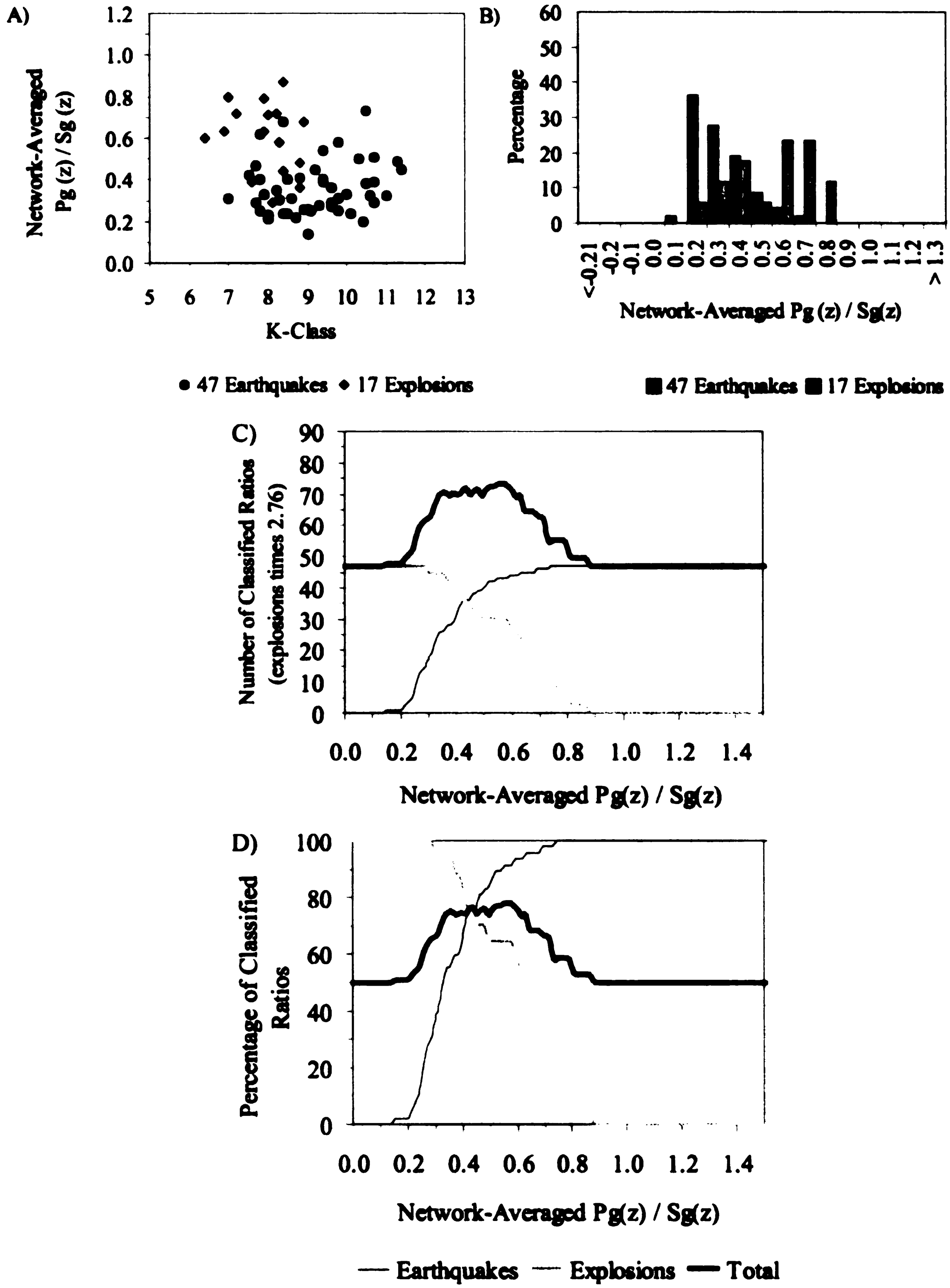


Figure 50. Pg(z)/Sg(z) NAP ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(z) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

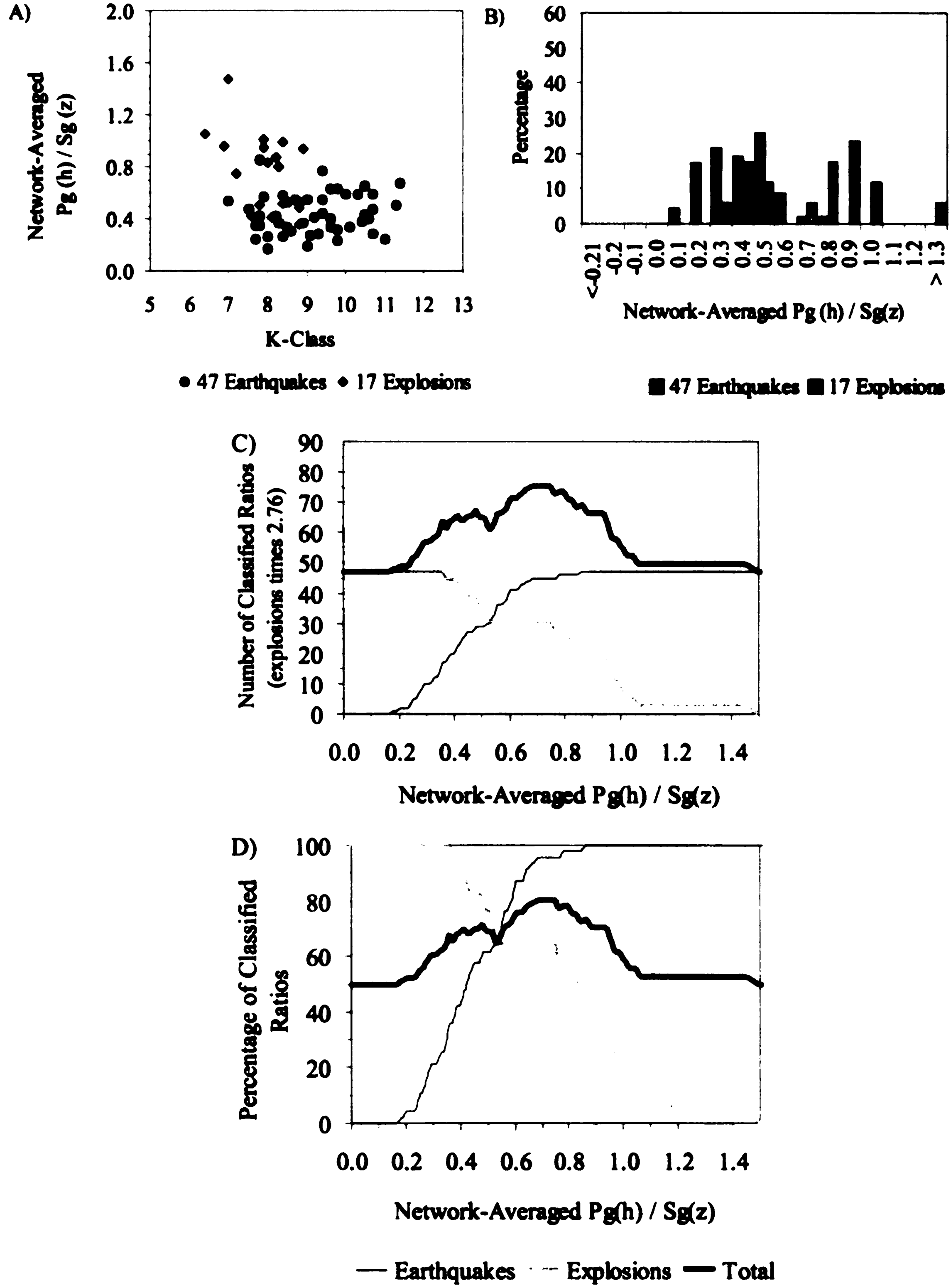


Figure 51. Pg(h)/Sg(z) NAP ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(z) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

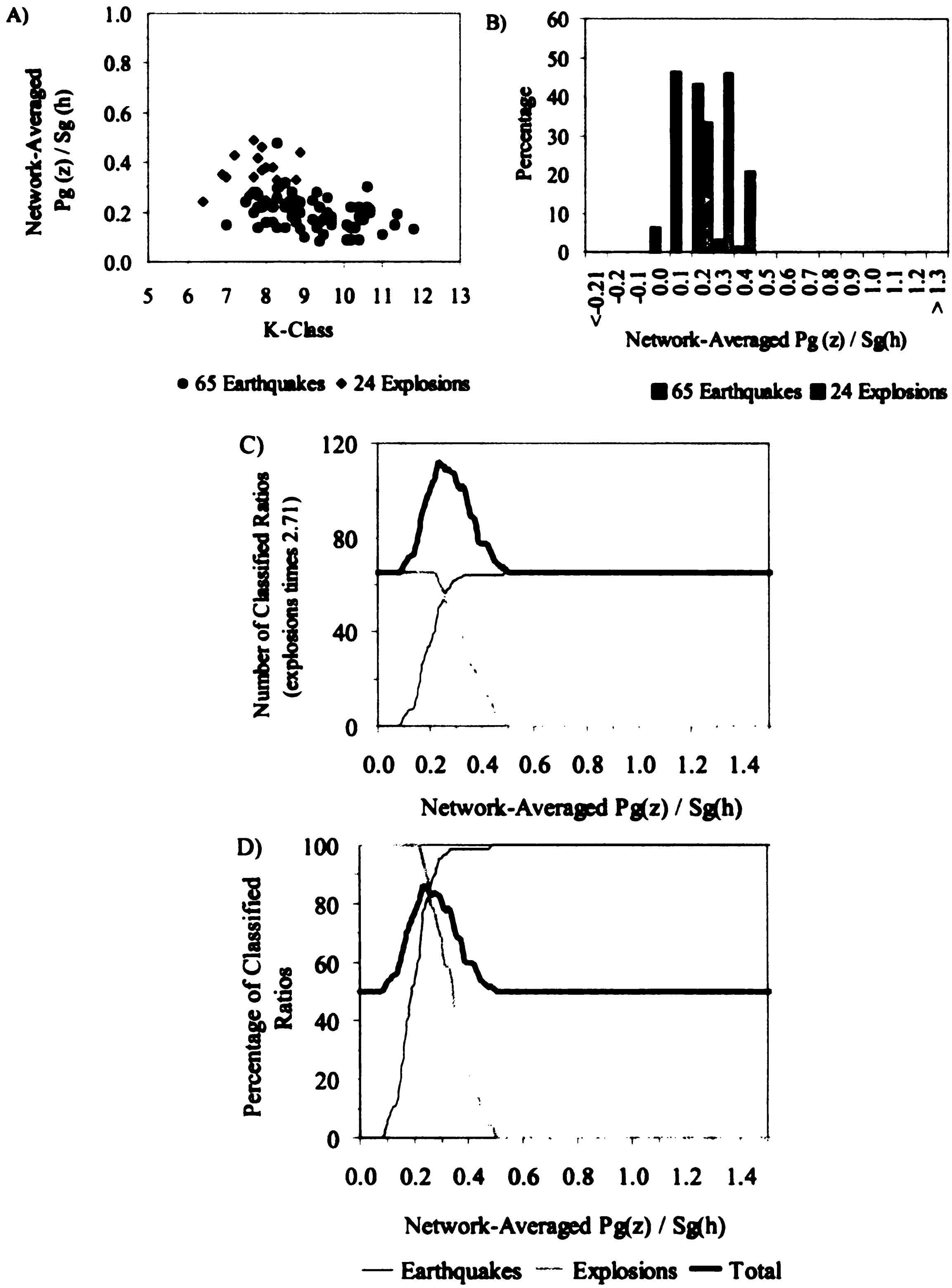


Figure 52. Pg(z)/Sg(h) NAP ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(h) NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

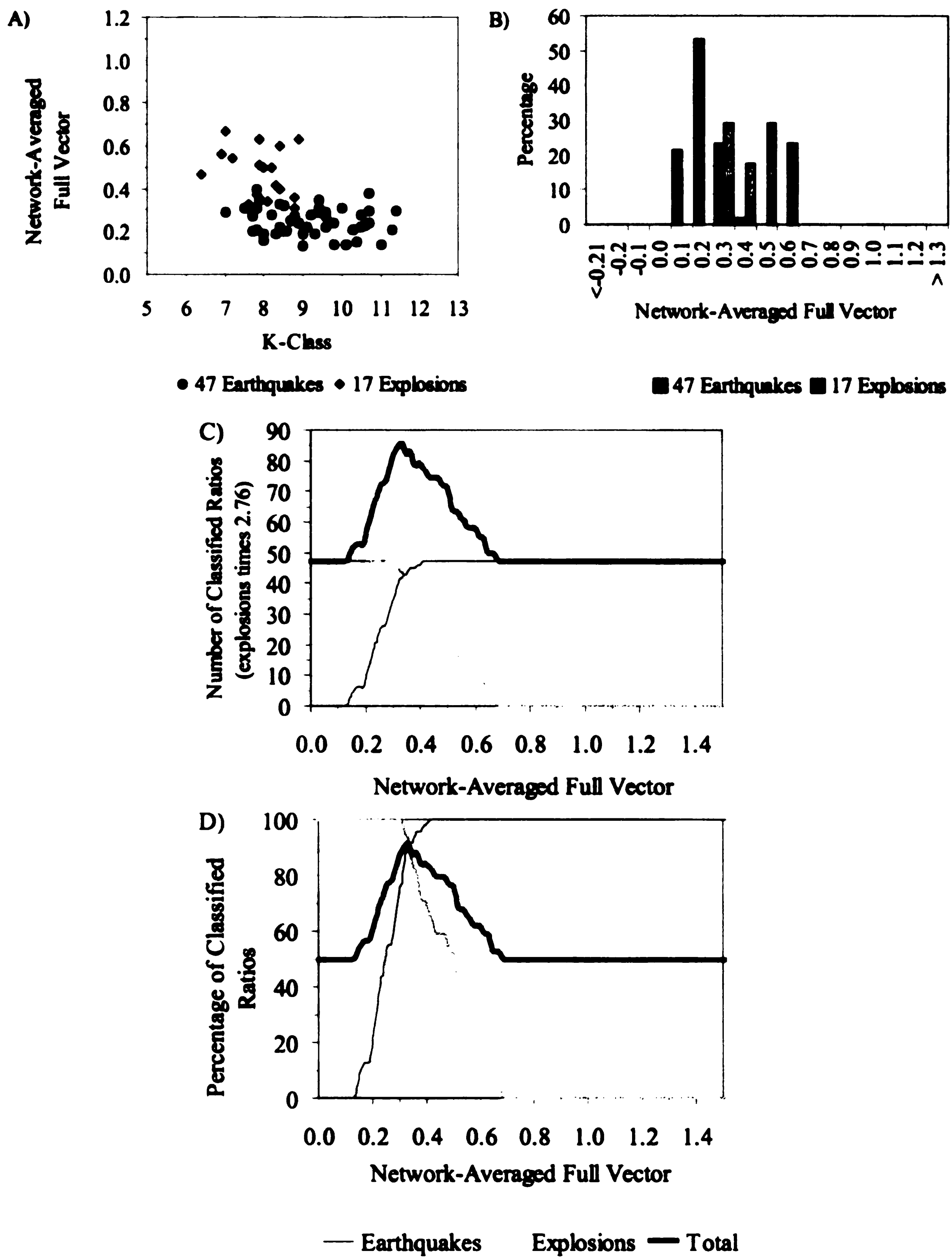


Figure 53. Full vector NAP ratio for the Magadan and Northern Yakutia regions. A) Full vector NAP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

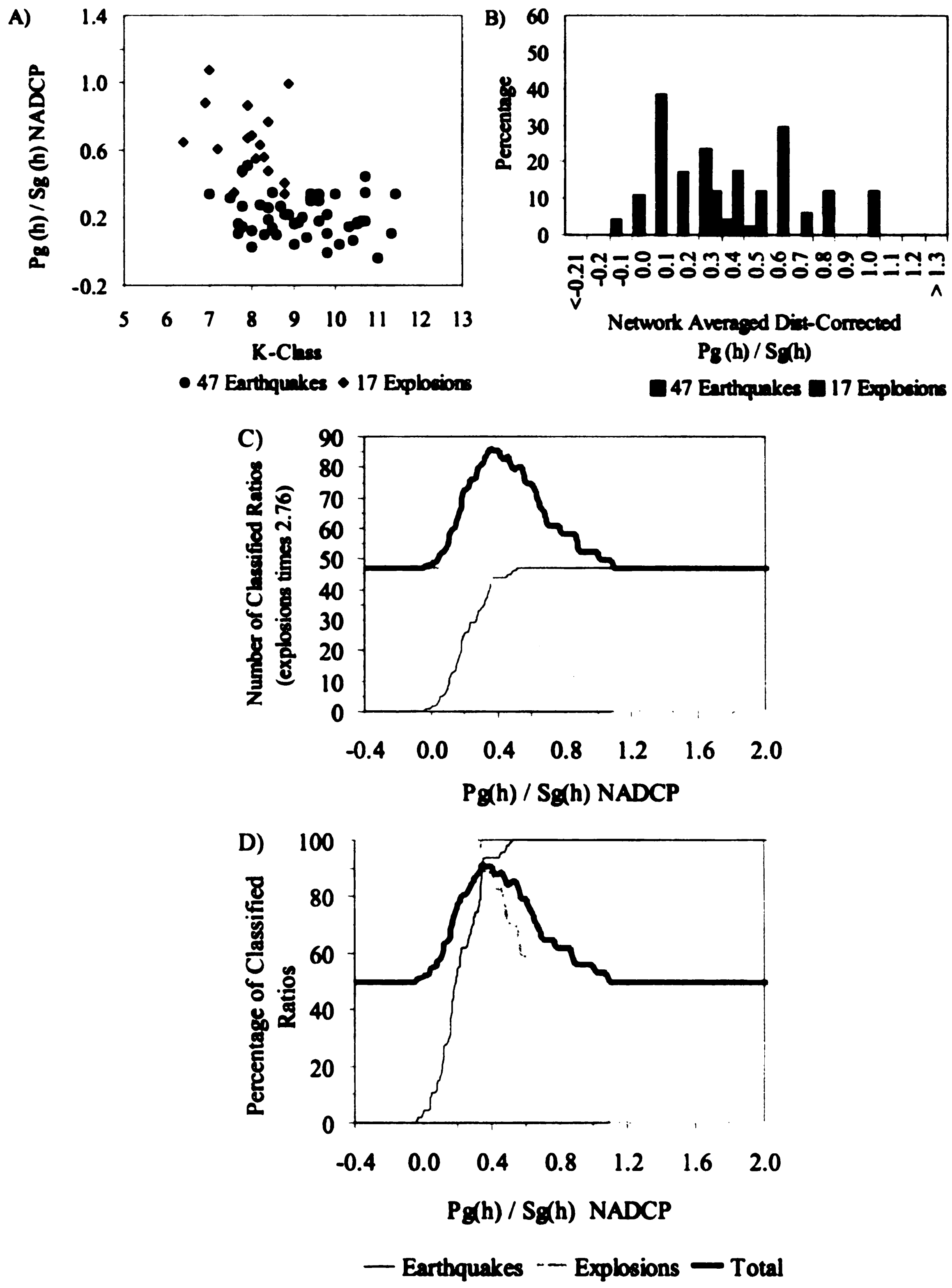


Figure 54. Pg(h)/Sg(h) NADCP ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(h) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

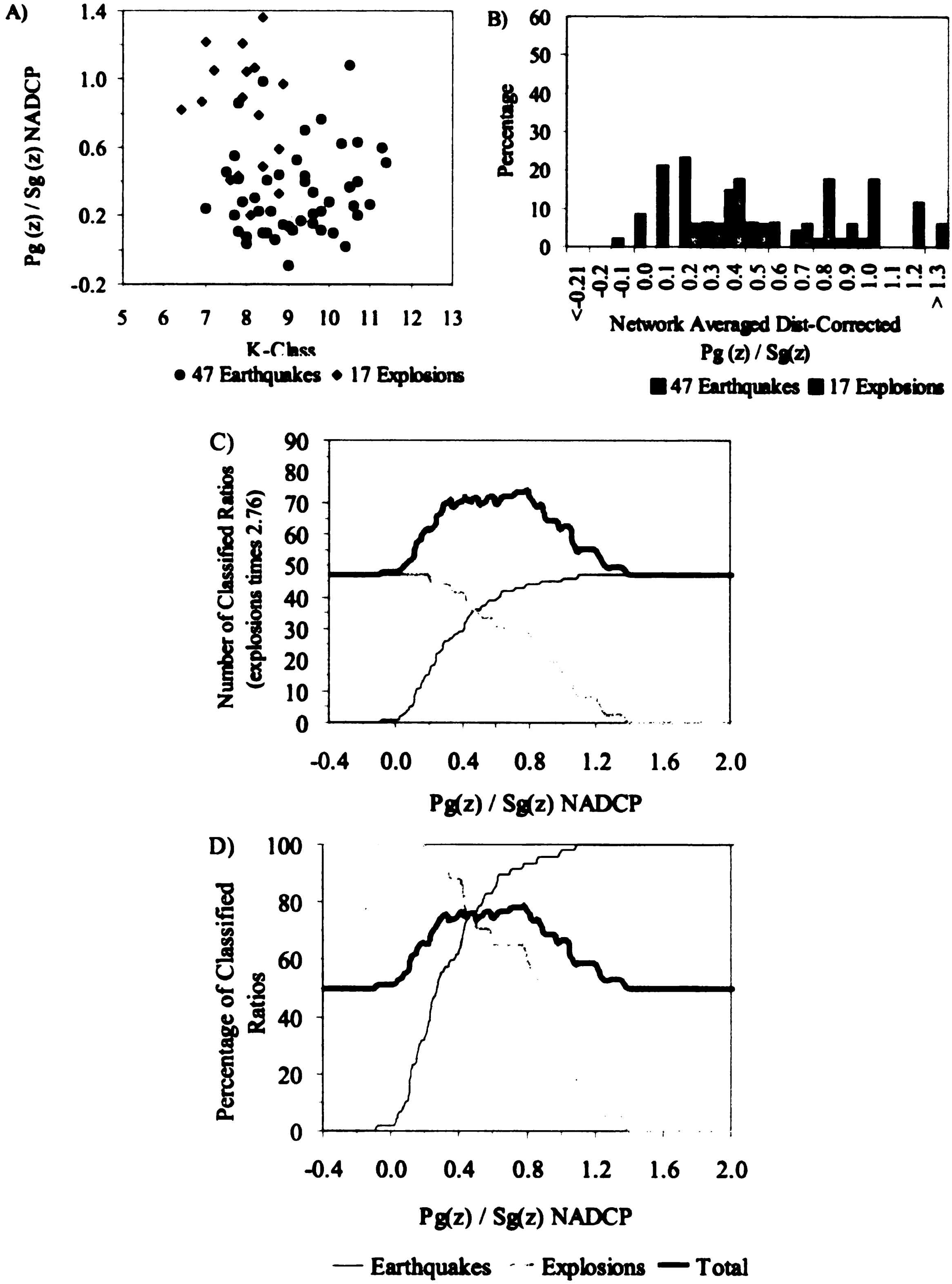


Figure 55. Pg(z)/Sg(z) NADCP ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(z) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

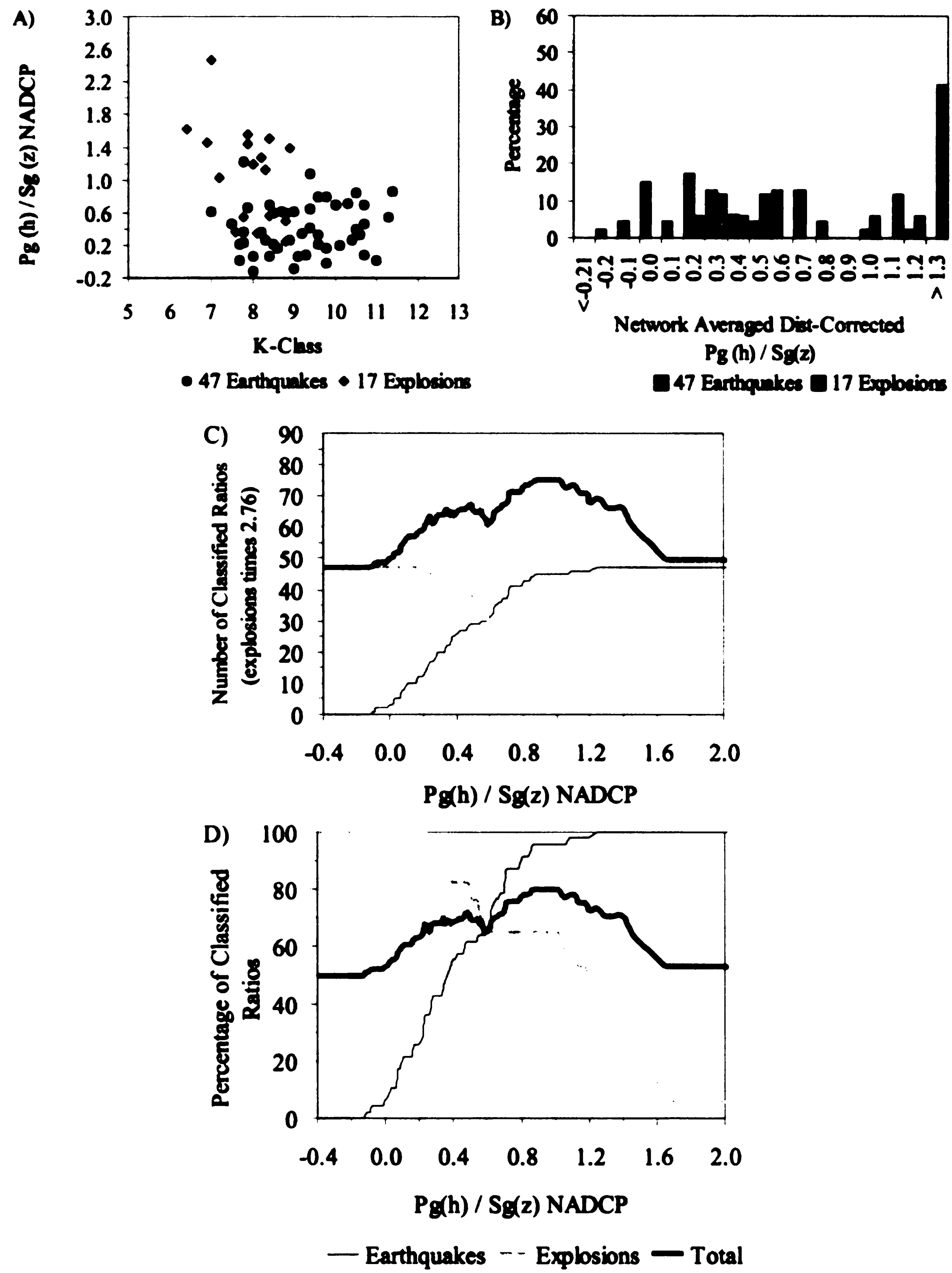


Figure 56. Pg(h)/Sg(z) NADCP ratio for the Magadan and Northern Yakutia regions. A) Pg(h)/Sg(z) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

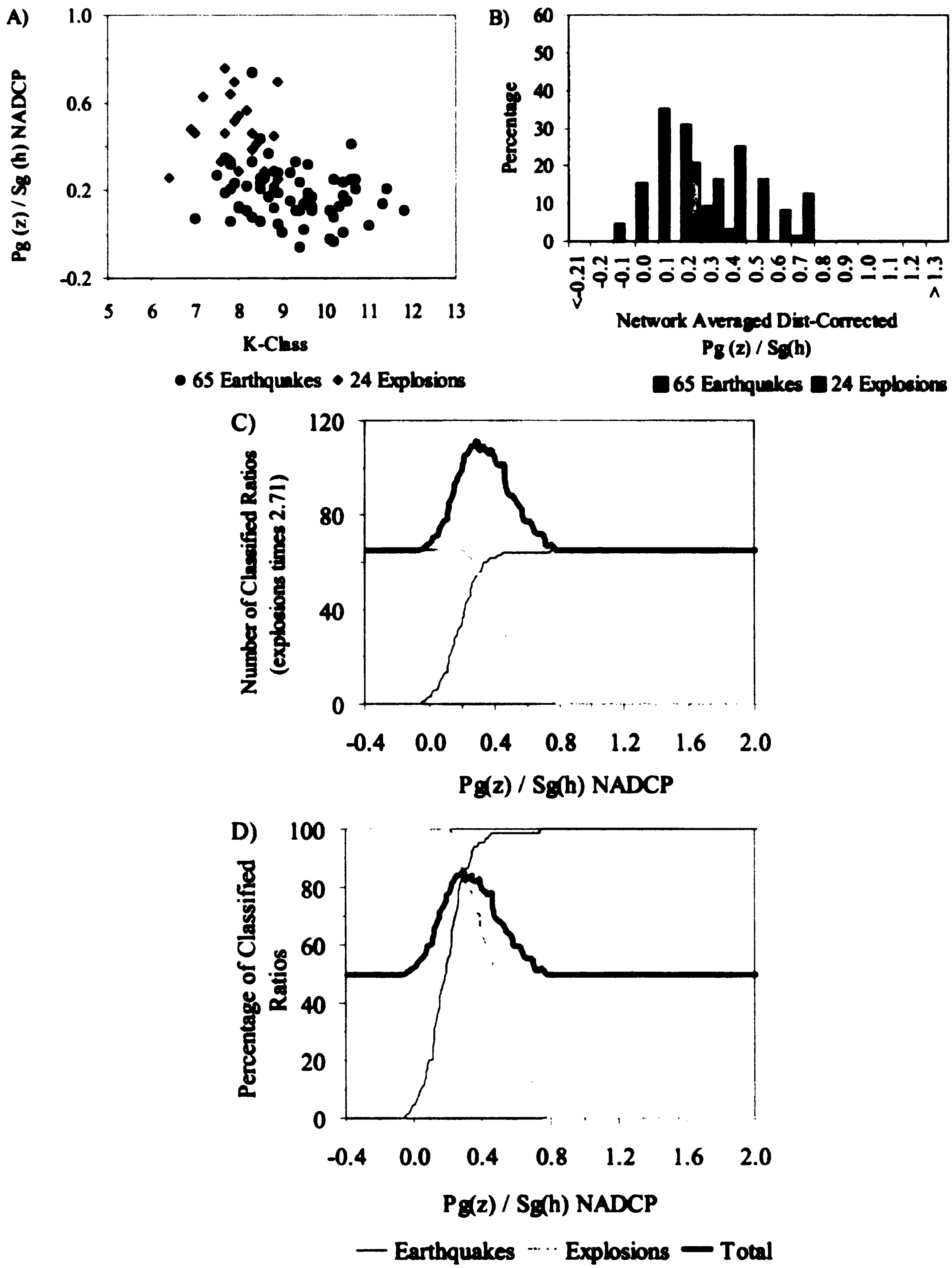


Figure 57. Pg(z)/Sg(h) NADCP ratio for the Magadan and Northern Yakutia regions. A) Pg(z)/Sg(h) NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

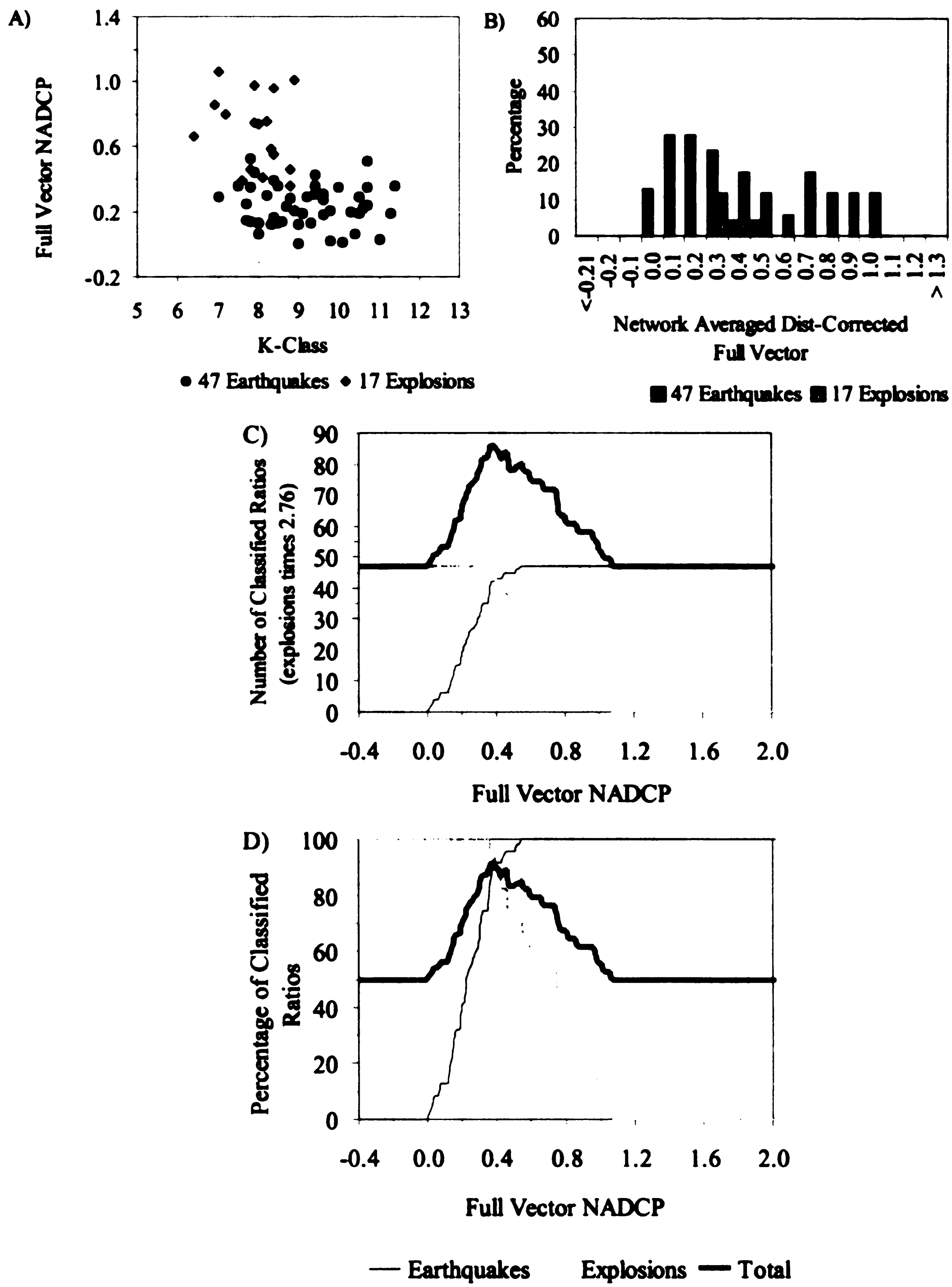


Figure 58. Full vector NADCP ratio for the Magadan and Northern Yakutia regions. A) Full vector NADCP ratio vs. K class. B) Histogram. C) Number of correctly classified events. D) Percentage of correctly classified events.

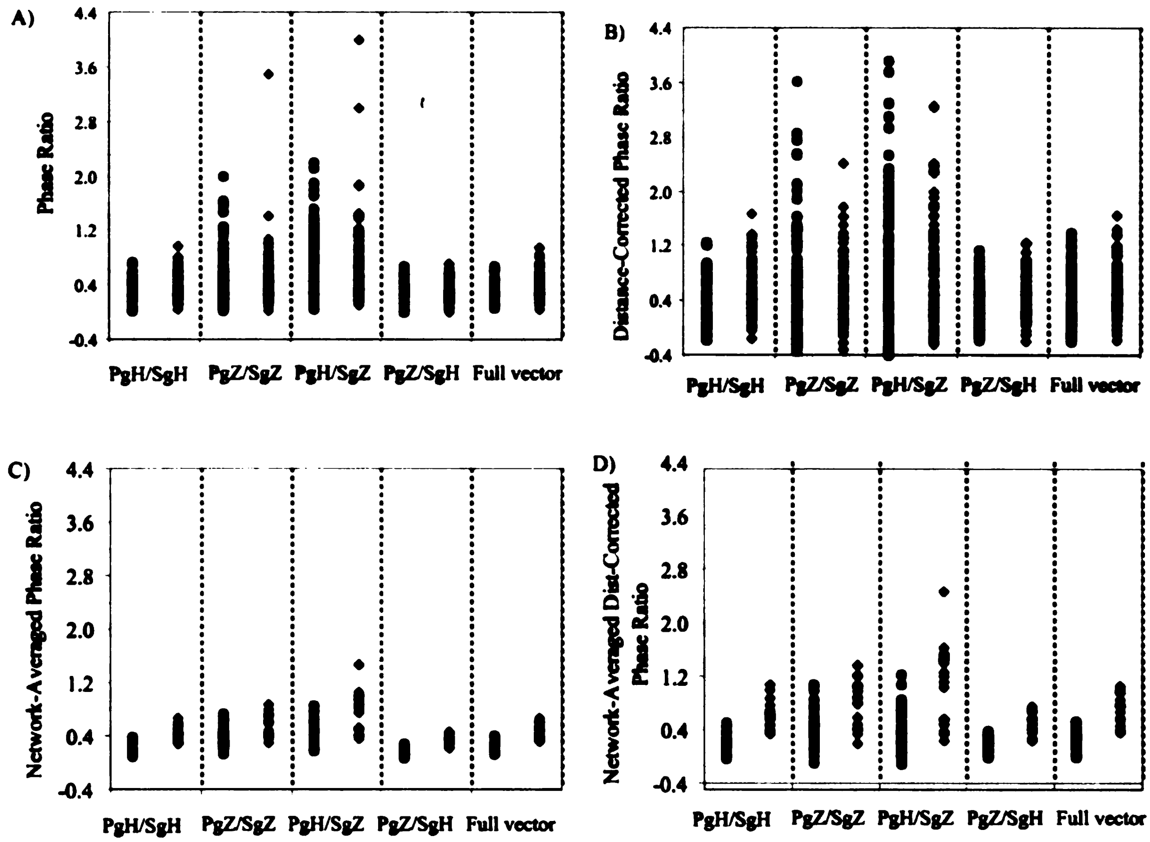


Figure 59. Comparison of amplitude ratios in the Magadan and Northern Yakutia regions. A) Raw phase ratio. B) DCP ratio. C) NAP ratio. D) NADCP phase ratio.

Table 13. Distance linear regression results of amplitude phase ratios calculated from earthquakes in the Magadan and Northern Yakutia regions

Phase Ratio	Slope	Y-intercept	R^2	Figure Reference
$\frac{Pg(h)}{Sg(h)}$	-0.0001	0.2543	0.01	Fig. 44a
$\frac{Pg(z)}{Sg(z)}$	0.00001	0.3797	0.00003	Fig. 45a
$\frac{Pg(h)}{Sg(z)}$	0.00003	0.4633	0.0001	Fig. 46a
$\frac{Pg(z)}{Sg(h)}$	-0.0002	0.2243	0.0296	Fig. 47a
Full vector	-0.0001	0.2934	0.0149	Fig. 48a

R^2 is the coefficient of determination. Values for R^2 near 0 indicate a weak ratio vs. distance trend, while values approaching to one indicate a strong ratio vs. distance dependence.

Table 14 and Figure 60 show the averages and standard deviations of the earthquake and explosion groups of all types of amplitude ratios calculated for the Magadan and Northern Yakutia regions. As observed in the Southern Yakutia region, the Pg(h)/Sg(z) amplitude ratio always had the largest standard deviation when compared to the rest of the amplitude ratios calculated using the same technique. In contrast, the Pg(z)/Sg(h) and Pg(h)/Sg(h) amplitude ratios usually had the smallest standard deviation compared to the rest of amplitude ratios calculated using the same technique (Fig. 60).

Table 14. Average, standard deviation, and maximum and minimum values obtained for the amplitude ratios in the Magadan and Northern Yakutia regions

Type of technique applied	Type of ratio	Type of event	Number of ratios	Average	σ	Max.	Min.
Raw Phase Ratio	Pg(h)/Sg(h)	Earthquakes	255	0.23	0.13	0.73	0.03
		Explosions	138	0.37	0.17	0.96	0.05
	Pg(z)/Sg(z)	Earthquakes	255	0.38	0.30	2.00	0.02
		Explosions	138	0.55	0.38	3.50	0.03
	Pg(h)/Sg(z)	Earthquakes	255	0.47	0.36	2.20	0.04
		Explosions	138	0.67	0.51	4.00	0.11
	Pg(z)/Sg(h)	Earthquakes	370	0.20	0.14	1.20	0.01
		Explosions	220	0.31	0.17	0.86	0.00
	Full vector	Earthquakes	255	0.26	0.14	0.82	0.04
		Explosions	138	0.41	0.17	0.95	0.05
Distance-Corrected Phase (DCP) Ratio	Pg(h)/Sg(h)	Earthquakes	255	0.23	0.26	1.25	-0.18
		Explosions	138	0.51	0.34	1.67	-0.15
	Pg(z)/Sg(z)	Earthquakes	255	0.38	0.59	3.61	-0.34
		Explosions	138	0.71	0.76	6.62	-0.32
	Pg(h)/Sg(z)	Earthquakes	255	0.47	0.72	3.91	-0.39
		Explosions	138	0.88	1.02	7.53	-0.24
	Pg(z)/Sg(h)	Earthquakes	370	0.20	0.27	2.18	-0.20
		Explosions	220	0.42	0.34	1.49	-0.24
	Full vector	Earthquakes	255	0.26	0.28	1.39	-0.20
		Explosions	138	0.56	0.34	1.65	-0.18
Network-Averaged Phase (NAP) Ratio	Pg(h)/Sg(h)	Earthquakes	47	0.22	0.06	0.37	0.09
		Explosions	17	0.44	0.11	0.66	0.28
	Pg(z)/Sg(z)	Earthquakes	47	0.36	0.13	0.73	0.14
		Explosions	17	0.59	0.17	0.87	0.29
	Pg(h)/Sg(z)	Earthquakes	47	0.44	0.15	0.85	0.17
		Explosions	17	0.78	0.29	1.47	0.36
	Pg(z)/Sg(h)	Earthquakes	65	0.19	0.07	0.48	0.08
		Explosions	24	0.34	0.07	0.49	0.22
	Full vector	Earthquakes	47	0.25	0.06	0.40	0.13
		Explosions	17	0.48	0.11	0.67	0.31
Network-Averaged Distance-Corrected Phase (NADCP) Ratio	Pg(h)/Sg(h)	Earthquakes	47	0.21	0.12	0.51	-0.04
		Explosions	17	0.65	0.21	1.08	0.34
	Pg(z)/Sg(z)	Earthquakes	47	0.34	0.25	1.08	-0.09
		Explosions	17	0.81	0.33	1.36	0.20
	Pg(h)/Sg(z)	Earthquakes	47	0.41	0.31	1.22	-0.12
		Explosions	17	1.10	0.58	2.47	0.24
	Pg(z)/Sg(h)	Earthquakes	65	0.19	0.13	0.74	-0.06
		Explosions	24	0.46	0.15	0.76	0.22
	Full vector	Earthquakes	47	0.24	0.13	0.53	0.00
		Explosions	17	0.69	0.23	1.06	0.36

σ is the standard deviation of the group of amplitude ratios.

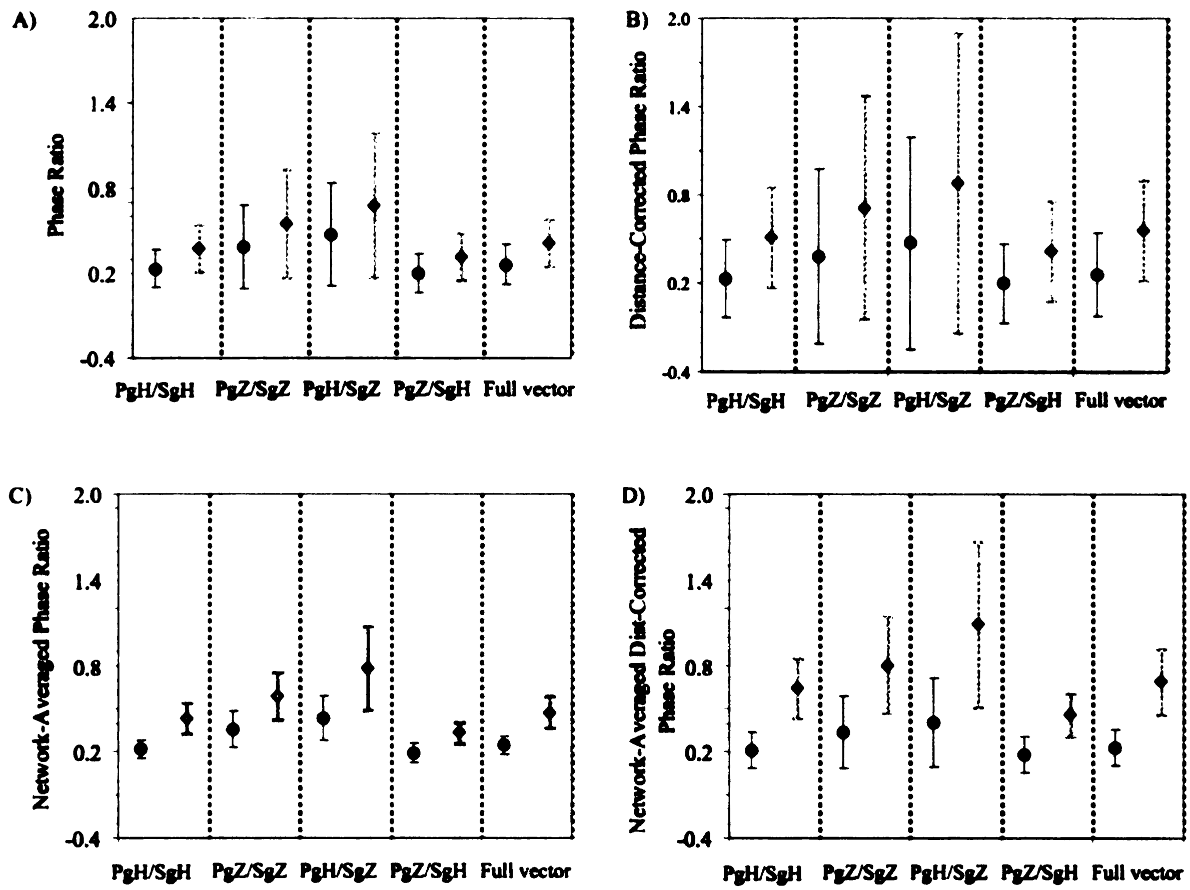


Figure 60. Comparison of amplitude ratios averages and standard deviations in the Magadan and Northern Yakutia regions. The average value is plotted with their arms representing the scatter in red for earthquakes and gray for explosions. A) Raw phase ratio. B) DCP ratio. C) NAP ratio. D) NADCP phase ratio.

The critical values found for the discriminants applied to the Magadan and Northern Yakutia regions are shown in Table 15 and in Figure 61. The best earthquake-explosion discriminants found for this region were the full vector NAP ratio and also the Pg(h)/Sg(h) and full vector NADCP ratio (Figs. 53, 54, and 58). These discriminants allows for the separation of 91.7% of the ratios that were calculated. Three more amplitude ratios were categorized as good discriminants with 86.1-91.0 % of the ratios correctly classified. These ratios were the Pg(z)/Sg(h) NADCP and also the Pg(h)/Sg(h) and Pg(z)/Sg(h) NAP ratios (Tables 15 and 16, Figs. 49, 52, and 57).

Table 15. Critical values for the Magadan and Northern Yakutia regions

Discrimant	Phase Ratio	DCP Ratio	NAP Ratio	NADCP Ratio
$\frac{Pg(h)}{Sg(h)}$	0.23	0.33	0.30-0.32	0.35
$\frac{Pg(z)}{Sg(z)}$	0.33	0.27-0.28	0.55-0.58	0.78-0.79
$\frac{Pg(h)}{Sg(z)}$	0.48	0.45	0.68-0.75	0.87-1.03
$\frac{Pg(z)}{Sg(h)}$	0.18	0.15	0.23	0.29
Full vector	0.27	0.25	0.33	0.37-0.39

Table 16. Maximum percentage of correctly classified events and qualitative performance assignment for each discriminant in the Magadan and Northern Yakutia regions

Discrimant	Phase Ratio	DCP Ratio	NAP Ratio	NADCP Ratio
$\frac{Pg(h)}{Sg(h)}$	Poor 70.7%	Poor 70.0%	Good 91.0%	Good 91.7%
$\frac{Pg(z)}{Sg(z)}$	Poor 63.8%	Poor 63.8%	Fair 78.1%	Fair 79.1%
$\frac{Pg(h)}{Sg(z)}$	Poor 62.8%	Poor 63.3%	Fair 80.2%	Fair 80.2%
$\frac{Pg(z)}{Sg(h)}$	Poor 67.0%	Poor 66.0%	Good 86.4%	Good 86.1%
Full vector	Poor 70.9%	Poor 70.8%	Good 91.7%	Good 91.7%

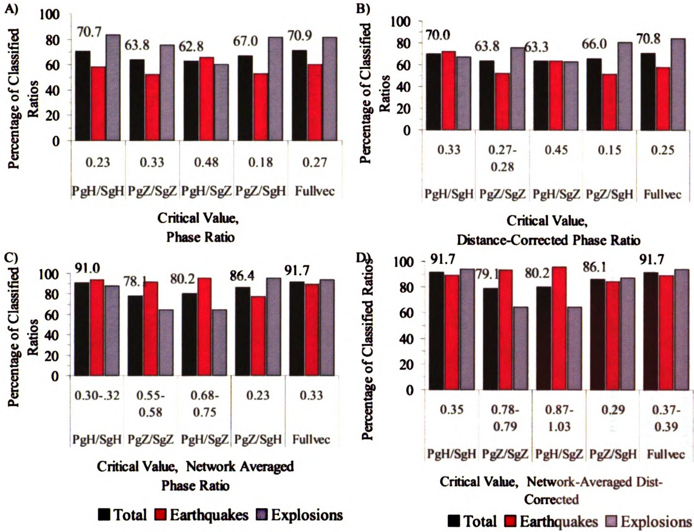


Figure 61. Comparison of the performance of the amplitude ratios in the Magadan and Northern Yakutia regions. A) Raw phase ratio. B) DCP ratio. C) NAP ratio. D) NADCP phase ratio.

The distance correction did not have a significant effect on the performance of the phase ratios after its application. The percentage of correctly classified events changed by -1.0 to 0.5%. The critical values slightly decreased for the Pg(z)/Sg(z), Pg(h)/Sg(z), Pg(z)/Sg(h), and full vector phase ratios and increased for P(h)/Sg(h) phase ratios (Table 15).

Averaging over the network again had a significant effect on the performance of the discriminants. The percentage of correctly classified events by the amplitude ratios increased by 14.3 to 20.8% after averaging. The full vector phase ratio had the most positive effect, followed by Pg(z)/Sg(h) phase ratio and then the Pg(h)/Sg(h) phase ratio (Table 16). The critical values increased for all types of phase ratios after averaging the ratios over the network, as seen in Table 15. The average over the network of the DCP ratios also always produced an increase in the critical values.

2.4.2. Phase Ratios for Individual Stations

Amplitude phase ratios obtained from individual stations were plotted against K class when more than ten amplitude phase ratios for both earthquakes and explosions were available for each station (Fig 38e). For the Magadan and Northern Yakutia region these stations were DBI, NKB, SEY, SUU, and UN1S.

The DCP ratios that performed the best were Pg(h)/Sg(h) for DBI, SUU, and UN1S and Pg(z)/Sg(h) for NKB and SEY (Fig 62, Appendix B). Due to the lack of data, the critical values and performance calculations for DBI and NKB stations are considered unreliable.

The critical values, averages, and standard deviations calculated were extremely variable, as seen in Table 17. There was not a pattern in the critical values or performance that could be observed for all types of amplitude ratios analyzed in this region. One notable observation situation was that the Pg(z)/Sg(z) and Pg(h)/Sg(z) DCP ratios showed a fair performance that was in some cases better than that of the other three types of amplitude ratios. Using all of the data collected for the region, the two aforementioned amplitude ratios performed more poorly and differently than the other three amplitude ratios calculated.

Table 17. Critical values, performances, averages, and standard deviations of DCP calculated for individual stations in the Magadan and Northern Yakutia regions

Station	# (1)	# (2)		Pg(h)/Sg(h)	Pg(z)/Sg(z)	Pg(h)/Sg(z)	Pg(z)/Sg(h)	Full Vector
DBI	14	10	Performance (%)	Fair (75.7%)	Poor (72.9%)	Poor (70.7%)	Poor (72.1%)	Poor (74.3%)
			Critical Value	0.26-0.29	1.45-1.60	0.46-0.86	0.26-0.32	0.55-0.56
			Average earthquake (σ)	0.27 (0.21)	0.69 (0.75)	0.59 (0.64)	0.31 (0.28)	0.36 (0.30)
			Average explosion (σ)	0.53 (0.26)	1.07 (0.69)	1.07 (0.81)	0.57 (0.41)	0.69 (0.39)
NKB	14	12	Performance (%)	Poor (73.9%)	Fair (80.4%)	Poor (74.3%)	Fair (83.9%)	Fair (81.1%)
			Critical Value	0.45-0.50	0.91-0.96	0.78-0.86	0.40	0.52-0.53
			Average earthquake (σ)	0.35 (0.30)	0.52 (0.53)	1.04 (0.92)	0.15 (0.17)	0.37 (0.29)
			Average explosion (σ)	0.68 (0.27)	1.28 (0.51)	1.48 (0.73)	0.62 (0.33)	0.82 (0.31)
SEY	26	14	Performance (%)	Fair (75.0%)	Fair (77.1%)	Fair (73.1%)	Fair (79.4%)	Fair (77.1%)
			Critical Value	0.13-0.16	0.23-0.38	0.10-0.15	0.21-0.23	0.25-0.27
			Average earthquake (σ)	0.21 (0.23)	0.20 (0.32)	0.39 (0.78)	0.14 (0.16)	0.22 (0.23)
			Average explosion (σ)	0.40 (0.16)	0.51 (0.27)	0.50 (0.27)	0.40 (0.20)	0.46 (0.18)
SUU	18	19	Performance (%)	Fair (81.4%)	Poor (66.9%)	Poor (72.5%)	Poor (69.7%)	Fair (78.6%)
			Critical Value	0.52	0.17-0.20	0.44-0.48	0.14	0.48
			Average earthquake (σ)	0.24 (0.19)	0.40 (0.49)	0.60 (0.71)	0.16 (0.17)	0.26 (0.22)
			Average explosion (σ)	0.79 (0.42)	0.62 (0.50)	1.20 (0.64)	0.40 (0.27)	0.73 (0.38)
UN1S	46	33	Performance (%)	Poor (68.9%)	Poor (59.8%)	Poor (67.6%)	Poor (67.6%)	Poor (67.2%)
			Critical Value	0.18-0.19	-0.02	0.10-0.11	0.14	0.21-0.22
			Average earthquake (σ)	0.26 (0.27)	0.20 (0.43)	0.31 (0.65)	0.18 (0.23)	0.24 (0.27)
			Average explosion (σ)	0.41 (0.27)	0.31 (0.54)	0.49 (0.96)	0.28 (0.23)	0.36 (0.25)

[1] number of ratios from earthquakes, [2] number of ratios from explosions, σ standard deviation of the group of amplitude ratios

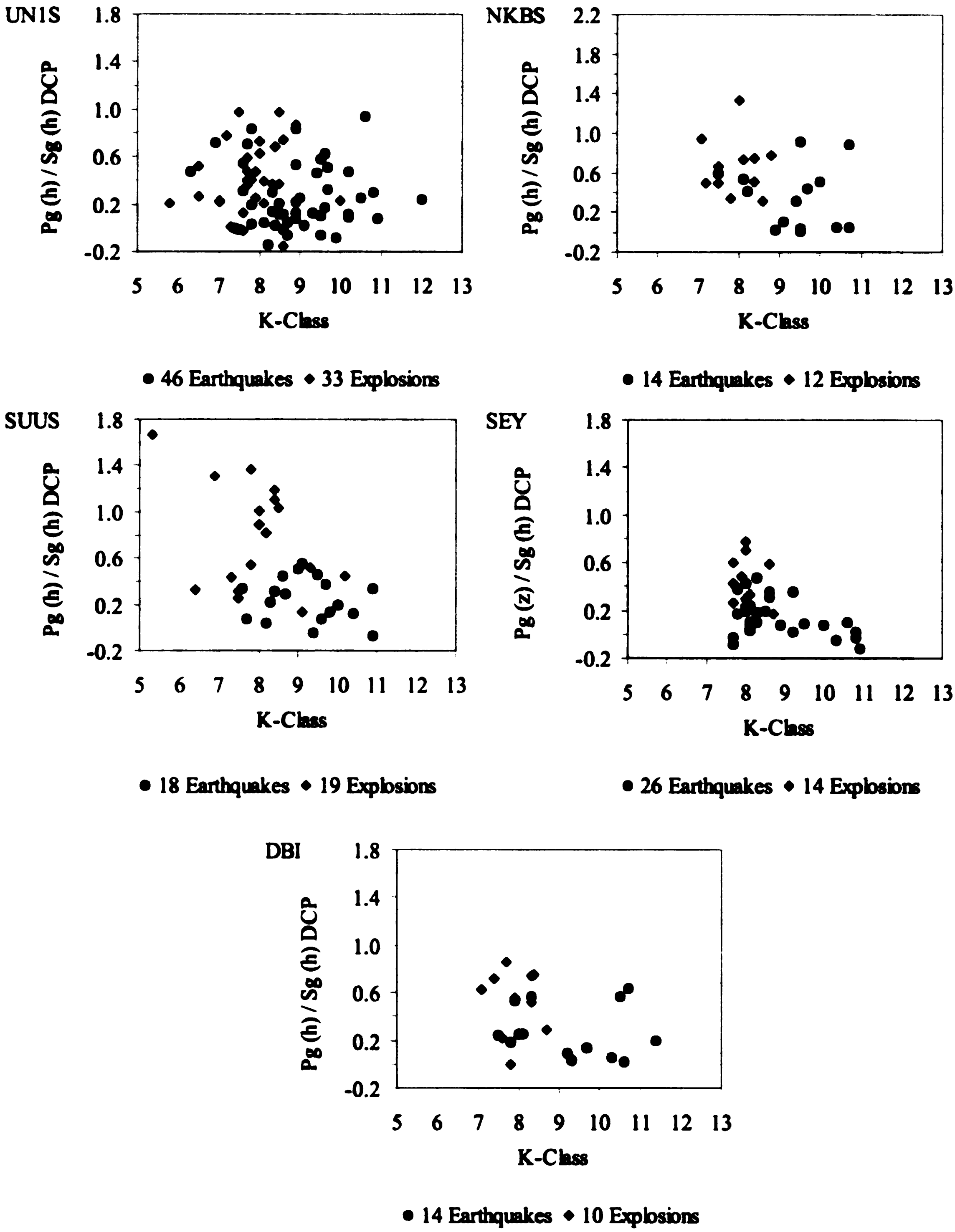


Figure 62. Best discriminants for individual stations in the Magadan and Northern Yakutia regions. The totality of the plots per station is shown in Appendix B.

2.5. Comparison between Regions

There was a tendency of explosions to have higher values than earthquakes for the five types of amplitude ratios explored in both of the two regions studied. However, an overlap between the two types of events was also observed for all the ratios calculated.

The amplitude ratios that exhibited the best performance as earthquake-explosion discriminants were the same for the two regions: the Pg(h)/Sg(h), Pg(z)/Sg(h), and the full vector NAP ratios and the Pg(h)/Sg(h), Pg(z)/Sg(h), and the full vector NADCP phase ratios (Tables 10 and 15). The percentage of correctly classified ratios that these types of discriminants produced was 86.8-89.1% for the Southern Yakutia region and 86.1-91.7% for the Magadan and Northern Yakutia regions. For the two regions, Pg(z)/Sg(z) and Pg(h)/Sg(z) performed similarly, but always with a percentage of correctly classified ratios considerably lower than that of the other three types of amplitude ratios.

The critical values for the amplitudes ratios of Pg(h)/Sg(h), Pg(z)/Sg(h), and full vector amplitude ratios were very similar for the two regions (Table 10 and 15, Fig. 63 a,d,e). On the other hand, the Pg(z)/Sg(z) and Pg(h)/Sg(z) phase ratios showed very distinct critical values for the two regions. These two types of amplitude ratios exhibited the worst performance for the two regions, and both ratios involved the amplitude of the Sg phase in the vertical component in the denominator.

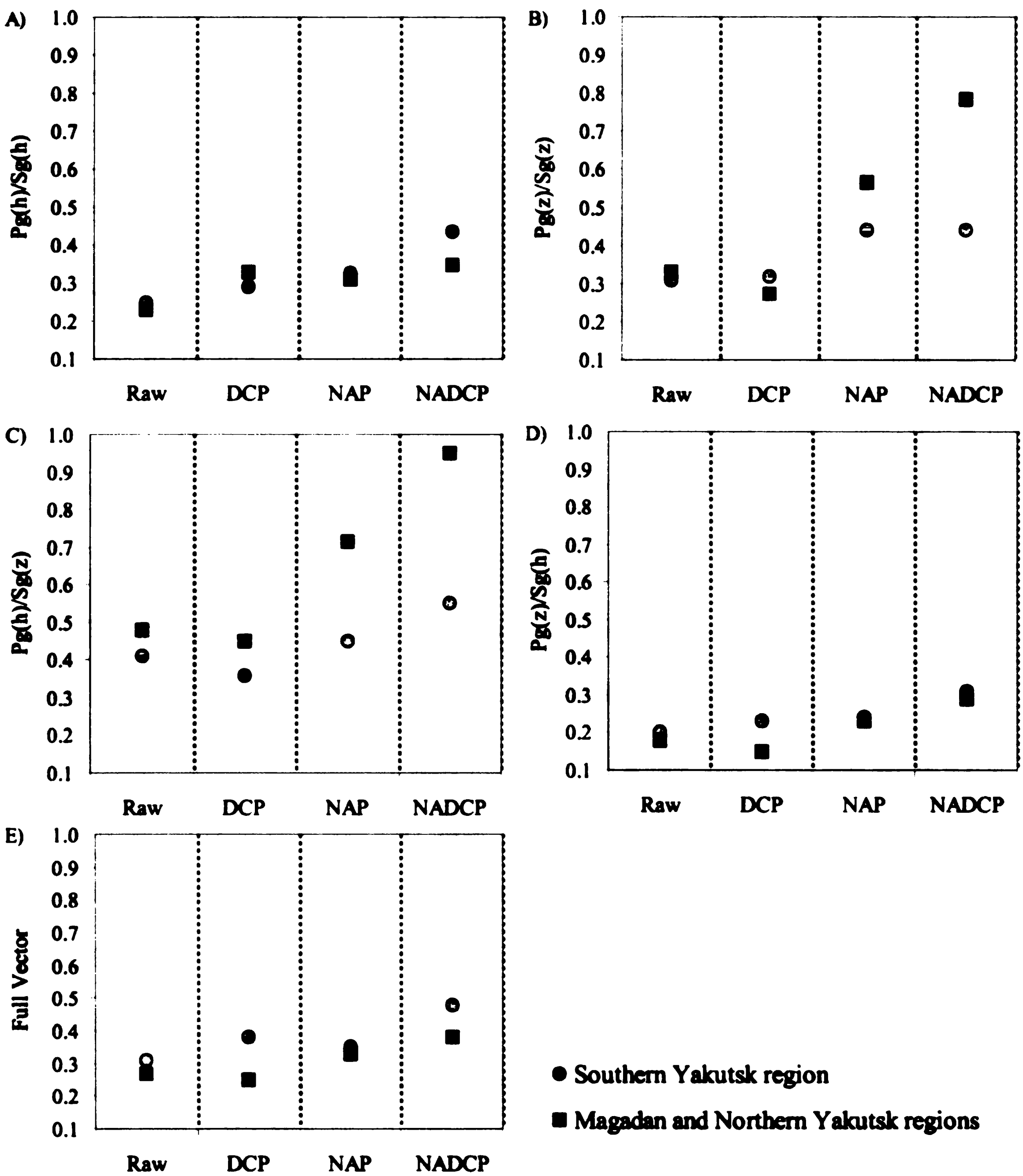


Figure 63. Comparison of critical values calculated using the four techniques applied to the two study regions. A) Pg(h)/Sg(h) phase ratio. B) Pg(z)/Sg(z) phase ratio C) Pg(h)/Sg(z) phase ratio. D) Pg(z)/Sg(h) phase ratio E) Full vector phase ratio.

The critical values found for the two regions usually did not separate an equal number of earthquakes and explosions (Fig. 36 and 61). This situation was more evident in the Magadan and Northern Yakutia regions than in the Southern Yakutia region.

For the two regions, the standard deviation of explosions was always higher than earthquakes (Fig. 64). In another words, there is a larger variation in the amplitude of Pg with respect to Sg for the explosions than for the earthquakes. The larger standard deviation for explosions could be the result of different techniques of blasting, geometries on the ripple fire detonations, and materials properties (gas porosity, density, velocity) in the near zone of the explosions.

For all types of amplitude phase ratios calculated, earthquakes from the Southern Yakutia region always had a slightly lower average amplitude ratio than earthquakes from the Magadan and Northern Yakutia regions (Fig. 64). However, it is important to notice that this difference is less than the standard deviation of the amplitude ratios for both regions. In the case of explosions, there was not a clear pattern. The average of amplitude ratios for explosions was usually slightly higher in the Southern Yakutia region for the phase ratios and DCP ratios. On the other hand, NAP and NADCP ratios were usually slightly lower in the Southern Yakutia region.

With the exception of the Pg(z)/Sg(z) and Pg(h)/Sg(z) phase ratios and the Pg(z)/Sg(z) DCP ratios, the standard deviations of the group of amplitude ratios from the Magadan and Northern Yakutia regions were always smaller than those of the Southern Yakutia region (Fig. 64). This was more significant in the case of explosions that had a much larger standard deviation for the Southern Yakutia region.

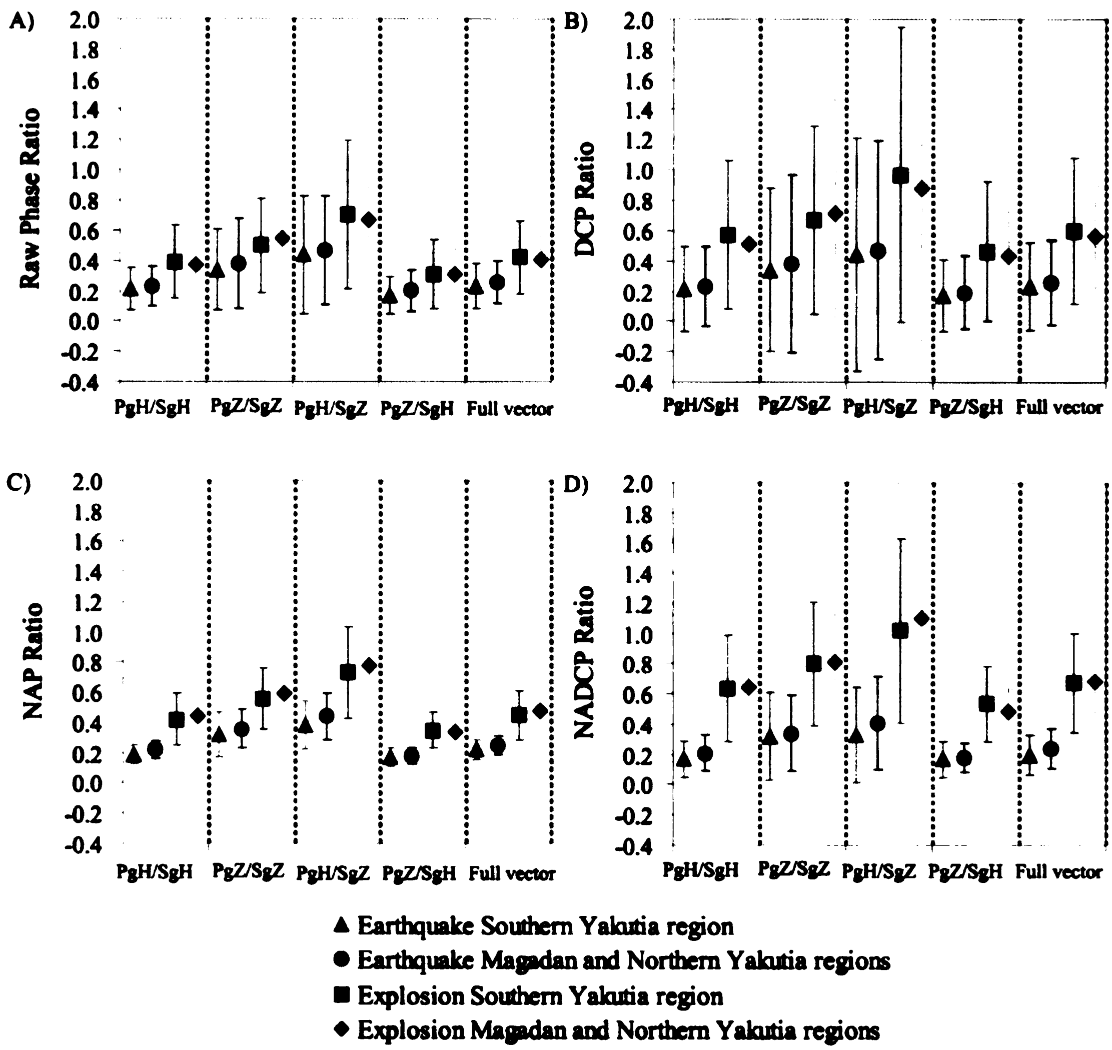


Figure 64. Comparison of averages and standard deviations of all type of amplitude phase ratios for the two study regions.

3. CONCLUSIONS

There was a tendency of chemical explosions to have higher values than earthquakes for the five types of amplitude ratios explored in the Yakutia and Magadan regions. The average of all types of amplitude phase ratios for explosions was always higher than earthquakes. However, an overlap in the values of the groups of the two types of events was also noticed, especially in the cases where the phase ratios were not averaged over the network.

The best earthquake-explosion discriminants found for the Southern Yakutia region and the Magadan and Northern Yakutia regions were: the Pg(h)/Sg(h), Pg(z)/Sg(h), and the full vector NAP ratios and the Pg(h)/Sg(h), Pg(z)/Sg(h), and the full vector NADCP phase ratios. The percentage of correctly classified ratios that these types of discriminants produced was 86.8-89.1% for the Southern Yakutia region and 86.1-91.7% for the Magadan and Northern Yakutia regions

Critical values were found for five types of amplitude ratios that were calculated in four different ways: the raw phase ratio and the DCP, NAP, and NADCP ratios (Table 10, 15). For earthquake-explosion discrimination purposes in the two regions studied, an amplitude phase ratio that is lower than the critical value is likely to be an earthquake while an amplitude phase ratio that is higher than the critical value is likely to be an explosion.

Good separations were found analyzing stations separately. In the Southern Yakutia region, the best separations were found at stations TUG, USZ, and UURS, while in the Magadan and Northern Yakutia regions the best separations were found at SUU and SEY.

There were no important differences in the performance and averages of amplitude phase ratios calculated between the two studied regions. The only important differences in the critical values were found for the two discriminants which performed badly: the Pg(z)/Sg(z) and Pg(h)/Sg(z) phase ratios.

The standard deviation of the group of explosions was always considerably larger than that of earthquakes for the two regions. The larger standard deviation for explosions could be the result of the variability in the techniques of blasting, geometries on the ripple fire detonations, and near-source materials properties (gas porosity, density, velocity) within the regions.

A weak earthquake amplitude phase ratio vs. distance relationship was found for the Yakutia and Magadan regions. For this reason, the distance correction did not have a significant effect on the performance of the amplitude ratios. More importantly, averaging the amplitude phase ratios when more than three stations were available reduced the scatter that the Pg/Sg phase ratios initially had and significantly improved the discrimination power of the amplitude ratios.

Despite the fact that this study was based on analog data collected only from short period instruments and analyzed without the use of corrections for seismic ray paths, it is significant that discrimination between the two types of events can be observed. This fact confirms that it is possible to conduct earthquake-explosion discrimination studies using historic Russian regional data. Nevertheless, in order to verify the results and increase the reability of the estimates, the use of the amplitude phase ratios with other alternative discriminants is recommended. Some of these could be the location of the source (known mines or faults), the time of occurrence (daytime vs. nighttime), and the sign of the first arrival.

Future work will attempt to use the totality of the amplitude information acquired to create more amplitude phase ratios of specific types. Future studies should also attempt to discriminate between earthquakes and explosions in the study area using waveforms recorded by recently installed digital seismic stations, which will allow better control of frequency bands for analysis and allow waveform correlation studies.

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APPENDICES

APPENDIX A

Amplitude Information

Earthquakes in the Southern Yakutia Region

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1985 218	14 22 33.0	55.35	123.34	UURS	9.49	6.6	0.156	0.044	0.113	0.613	1.322	0.510
1985 218	14 22 33.0	55.35	123.34	USZ	173.22	8.9	0.020	0.022	0.005	0.100	0.198	0.144
19851116	17 22 18.0	56.33	123.08	CLNS	125.10	9.6	0.060	0.070	0.100	0.350	0.380	0.350
19851116	17 22 18.0	56.33	123.08	TUG	142.94	10.4	0.130	0.180	0.100	0.900	1.480	1.070
1986 1 2	20 08 52.4	56.18	123.60	CLNS	108.45	7.9	---	0.007	0.013	0.099	0.081	0.032
1986 1 2	20 08 52.4	56.18	123.60	UURS	100.82	7.9	0.005	0.008	0.015	0.037	0.068	0.046
1986 1 2	20 08 52.4	56.18	123.60	USZ	130.80	8.7	0.014	0.006	0.006	0.189	0.076	0.078
1986 1 2	20 08 52.4	56.18	123.60	TUG	177.32	8.9	0.005	0.005	0.006	0.150	0.155	0.090
1986 1 2	20 08 52.4	56.18	123.60	CGD	507.53	8.9	0.014	0.007	0.008	0.036	0.015	0.020
1986 1 7	18 18 5.0	57.54	128.50	CGD	183.19	8.0	0.007	0.003	0.008	0.058	0.023	0.034
1986 118	21 19 58.0	55.70	124.40	UURS	86.84	8.1	0.005	---	0.004	0.043	0.068	0.015
1986 118	21 19 58.0	55.70	124.40	CLNS	130.54	7.5	---	0.013	0.013	0.040	0.040	0.038
1986 2 7	18 16 28.7	56.62	121.10	USZ	30.83	7.7	---	---	0.012	0.122	0.104	---
1986 2 9	12 37 16.7	56.69	122.14	USZ	36.50	7.2	---	---	0.014	0.162	0.193	0.170
1986 2 9	12 37 16.7	56.69	122.14	TUG	75.92	8.2	---	---	0.123	0.108	0.111	---
1986 211	17 51 20.5	57.03	127.33	CLNS	148.99	9.9	0.079	0.108	0.126	0.395	0.620	0.405
1986 211	17 51 20.5	57.03	127.33	CGD	272.69	10.1	0.029	0.027	0.015	0.504	0.204	0.212
1986 211	17 51 20.5	57.03	127.33	USZ	353.36	10.0	0.027	0.076	0.067	0.243	0.126	0.145
1986 211	17 51 20.5	57.03	127.33	TUG	353.93	9.7	0.011	0.022	0.011	0.171	0.133	0.147
1986 214	20 46 58.1	57.53	125.42	CLNS	82.91	8.9	0.040	0.020	0.025	0.316	0.270	0.101
1986 214	20 46 58.1	57.53	125.42	TUG	237.89	8.3	0.005	0.005	0.011	0.064	0.033	0.045
1986 214	20 46 58.1	57.53	125.42	USZ	255.48	8.3	0.003	0.006	0.006	0.054	0.025	0.211
1986 220	17 51 8.4	56.88	120.83	TUG	58.52	8.1	---	---	0.027	0.192	0.231	0.180
1986 220	17 51 8.4	56.88	120.83	USZ	58.47	8.0	---	---	0.022	0.243	0.303	0.100
1986 224	17 47 18.9	56.63	123.07	TUG	119.90	7.5	---	---	0.030	0.042	0.040	0.030

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 227	13 18 45.7	57.57	125.38	CLNS	86.20	8.3	0.080	0.080	0.100	0.150	0.170	0.160
1986 227	13 18 45.7	57.57	125.38	TUG	235.97	8.1	0.010	0.010	0.013	0.030	0.035	0.030
1986 227	16 38 46.9	57.57	125.48	CLNS	88.41	10.0	---	---	0.050	0.670	0.120	0.150
1986 227	16 38 46.9	57.57	125.48	TUG	241.90	9.8	0.040	0.060	0.070	0.350	0.300	0.150
1986 227	16 38 46.9	57.57	125.48	USZ	260.54	9.2	0.030	---	0.040	0.170	0.100	0.110
1986 227	16 38 46.9	57.57	125.48	CGD	328.70	9.9	0.030	0.040	0.036	0.280	0.160	0.140
1986 227	16 38 46.9	57.57	125.48	KROS	361.78	9.4	0.020	0.010	0.020	0.050	0.110	0.030
1986 227	20 13 46.1	57.56	125.46	CLNS	86.93	10.1	---	0.050	0.040	1.600	0.780	---
1986 227	20 13 46.1	57.56	125.46	TUG	240.59	10.1	0.050	0.100	0.080	0.500	0.360	0.240
1986 227	20 13 46.1	57.56	125.46	UURS	286.77	9.1	0.040	---	0.037	0.110	0.240	0.210
1986 227	20 13 46.1	57.56	125.46	CGD	330.26	10.2	0.070	0.070	0.045	0.460	0.220	0.250
1986 3 3	13 09 33.0	56.31	122.85	USZ	82.28	8.4	0.013	0.006	0.005	0.189	0.114	0.111
1986 3 3	13 09 33.0	56.31	122.85	UURS	114.67	8.3	0.010	0.017	0.015	0.106	0.068	0.046
1986 3 3	13 09 33.0	56.31	122.85	TUG	135.55	9.2	0.021	0.022	0.022	0.300	0.222	0.158
1986 3 3	13 09 33.0	56.31	122.85	CLNS	138.77	7.8	0.019	0.006	0.006	0.059	0.026	0.025
1986 412	12 41 33.3	56.44	123.29	USZ	105.13	8.5	---	---	0.034	0.203	0.145	---
1986 412	12 41 33.3	56.44	123.29	CLNS	108.09	8.7	---	---	0.030	0.278	0.175	---
1986 412	12 41 33.3	56.44	123.29	TUG	143.69	8.5	---	---	0.034	0.107	0.133	0.079
1986 427	15 45 26.9	56.86	122.61	USZ	70.50	6.5	---	---	0.016	0.019	0.018	---
1986 5 8	18 21 3.4	55.30	123.55	USZ	185.94	9.0	---	---	0.016	0.189	0.202	---
1986 5 8	18 21 3.4	55.30	123.55	CLNS	190.72	9.4	---	---	0.038	0.357	0.189	---
1986 5 8	18 21 3.4	55.30	123.55	KROS	240.22	8.9	---	---	0.015	0.121	0.007	0.074
1986 6 1	12 13 58.6	56.60	121.18	USZ	25.56	6.4	0.008	---	0.013	0.057	0.045	0.045
1986 6 1	12 13 58.6	56.60	121.18	TUG	76.71	7.4	---	---	0.005	0.040	0.070	0.050
1986 6 3	12 49 40.8	55.89	124.30	USZ	183.37	8.3	---	0.013	0.010	0.110	0.080	0.050
1986 6 3	12 49 40.8	55.89	124.30	TUG	231.11	9.0	0.012	0.012	0.013	0.140	0.120	0.140

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 6 5	17 48 8.2	57.59	125.39	CLNS	88.52	7.2	---	---	0.005	0.150	0.060	0.040
1986 610	14 10 7.0	57.38	122.80	TUG	80.22	9.4	0.120	0.190	0.130	0.560	0.490	0.250
1986 610	14 10 7.0	57.38	122.80	USZ	116.91	8.4	0.030	0.030	0.030	0.100	0.080	0.090
1986 610	14 10 7.0	57.38	122.80	CLNS	140.37	8.7	0.030	0.020	0.070	0.170	0.060	0.046
1986 619	15 51 32.9	56.67	121.32	USZ	20.60	5.2	---	---	0.004	0.040	0.030	0.044
1986 7 6	13 53 58.2	57.62	120.93	USZ	124.40	10.1	0.133	0.067	0.183	0.512	0.923	0.394
1986 7 6	13 53 58.2	57.62	120.93	CLNS	254.28	9.9	0.020	0.024	0.054	0.408	0.194	0.182
1986 7 6	13 53 58.2	57.62	120.93	UURS	293.85	9.7	0.049	0.076	0.036	0.186	0.269	0.054
1986 713	15 34 53.5	56.54	121.00	USZ	36.35	6.5	0.002	0.023	0.019	0.040	0.068	0.067
1986 713	15 34 53.5	56.54	121.00	TUG	86.28	7.0	0.005	0.005	0.006	0.021	0.022	0.012
1986 726	21 21 1.8	56.56	120.93	TUG	85.77	7.0	0.012	0.009	0.009	0.021	0.022	0.012
1986 8 4	18 36 36.1	57.09	122.36	TUG	56.72	8.4	0.021	0.044	0.023	0.256	0.350	0.117
1986 8 7	18 51 24.0	55.10	123.30	USZ	194.44	10.0	0.245	0.169	0.193	1.373	1.689	---
1986 8 7	18 51 24.0	55.10	123.30	TUG	266.39	11.0	0.213	0.110	0.187	1.386	0.878	0.843
1986 8 7	18 51 24.0	55.10	123.30	CGD	601.24	12.2	0.231	0.287	0.072	0.972	1.410	1.037
1986 812	16 06 23.2	56.58	121.17	USZ	25.94	8.0	0.061	0.101	0.158	0.665	0.765	0.809
1986 812	16 06 23.2	56.58	121.17	TUG	79.05	9.1	0.085	0.076	0.082	0.267	0.504	0.252
1986 812	16 06 23.2	56.58	121.17	CLNS	229.57	9.1	0.010	0.016	0.054	0.132	0.081	0.109
1986 813	19 36 36.2	57.32	122.10	TUG	37.72	8.3	0.010	0.021	0.041	0.683	0.416	0.199
1986 813	19 36 36.2	57.32	122.10	USZ	89.88	7.7	0.005	0.005	0.024	0.040	0.039	0.028
1986 822	15 34 5.8	56.87	120.09	TUG	95.12	7.6	0.011	0.011	0.012	0.040	0.043	0.028
1986 822	15 34 5.8	56.87	120.09	USZ	97.91	7.3	0.004	0.004	0.010	0.029	0.021	0.018
1986 827	15 47 7.2	57.70	127.40	CLNS	178.21	7.5	---	---	0.012	0.035	0.031	---
1986 915	17 37 34.2	57.00	123.80	CLNS	69.11	6.8	---	---	0.009	0.033	0.016	---
1987 620	14 54 30.6	57.49	128.28	CGD	196.19	8.7	0.021	0.016	0.017	0.156	0.060	0.029
198710 2	12 51 47.8	56.22	124.82	CLNS	69.16	7.6	0.011	0.009	0.020	0.039	0.037	0.018

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
198710 5	15 57 58.2	56.82	123.09	USZ	95.95	7.9	0.017	0.009	0.009	0.074	0.041	0.039
198710 5	15 57 58.2	56.82	123.09	TUG	109.55	7.5	0.014	0.015	0.009	0.036	0.025	0.022
198710 5	15 57 58.2	56.82	123.09	UURS	169.28	8.2	0.006	0.017	0.010	0.022	0.075	0.020
198710 5	16 00 41.9	56.85	123.00	TUG	103.13	7.6	0.009	0.009	0.009	0.029	0.040	0.081
198710 5	16 00 41.9	56.85	123.00	UURS	172.96	8.1	0.011	0.010	0.005	0.040	0.072	0.022
19871012	14 04 27.0	56.55	121.02	USZ	35.05	6.8	0.025	0.009	0.021	0.094	0.080	0.079
19871020	12 08 30.8	54.01	128.00	UURS	339.56	9.4	0.010	0.047	0.017	0.122	0.090	0.105
19871020	12 08 30.8	54.01	128.00	TUG	546.51	9.6	0.008	0.005	0.004	0.059	0.072	0.056
19871022	15 07 2.4	56.83	120.97	USZ	48.33	8.6	0.033	0.034	0.034	0.724	0.240	0.270
19871022	21 47 11.1	56.87	121.04	USZ	48.13	7.8	0.110	0.034	0.023	0.230	0.183	0.169
19871025	19 09 9.0	56.59	120.92	USZ	41.25	6.0	0.005	0.004	0.005	0.020	0.032	0.021
19871026	18 05 23.3	56.60	121.07	TUG	78.56	6.5	---	---	0.004	0.010	0.025	0.016
19871029	19 18 1.0	57.72	124.57	TUG	191.37	8.5	0.010	0.030	0.007	0.101	0.068	0.022
19871029	19 18 1.0	57.72	124.57	USZ	221.19	7.0	0.003	0.004	0.003	0.009	0.010	0.010
19871029	19 56 1.5	57.81	121.68	TUG	61.25	7.3	0.009	0.005	0.016	0.094	0.020	0.081
19871030	15 44 7.2	57.29	125.26	KROS	336.02	9.3	---	---	0.005	0.030	0.040	0.022
198711 2	16 04 27.0	57.40	124.90	CLNS	62.33	6.5	---	---	0.006	0.026	0.038	0.027
198711 4	14 42 5.5	56.57	121.03	USZ	34.43	7.4	0.020	0.021	0.024	0.200	0.220	0.200
198711 4	14 42 5.5	56.57	121.03	TUG	82.54	8.4	0.045	0.039	0.027	0.130	0.130	0.074
19871110	16 44 51.4	56.69	124.56	USZ	182.21	7.5	0.006	---	0.018	0.026	0.029	0.022
19871113	12 21 44.2	57.23	120.80	USZ	88.61	7.2	0.007	0.015	0.020	0.049	0.021	0.099
19871114	14 50 29.7	56.59	121.13	USZ	28.42	7.0	0.016	0.006	0.011	0.180	0.188	0.212
19871114	14 50 29.7	56.59	121.13	TUG	78.56	8.4	0.025	0.028	0.034	0.050	0.228	0.057
19871114	14 50 29.7	56.59	121.13	UURS	193.62	8.6	0.009	0.018	0.013	0.133	0.074	0.026
19871114	14 50 29.7	56.59	121.13	CLNS	231.82	8.1	0.004	0.008	0.009	0.050	0.038	0.037
19871114	14 50 29.7	56.59	121.13	KROS	440.01	8.0	---	---	0.003	0.029	0.017	0.011

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
19871114	20 18 3.0	56.58	121.08	USZ	31.44	7.0	0.042	0.015	0.034	0.133	0.193	0.146
19871114	20 18 3.0	56.58	121.08	TUG	80.53	7.9	0.014	0.028	0.012	0.054	0.111	0.049
19871114	20 18 3.0	56.58	121.08	CLNS	235.02	7.5	---	---	0.005	0.026	0.023	0.019
19871116	14 14 48.3	57.59	125.43	CLNS	89.35	8.1	0.009	0.008	0.018	0.088	0.106	0.095
19871116	14 14 48.3	57.59	125.43	TUG	239.19	7.7	0.006	0.007	0.003	0.023	0.028	0.011
19871116	14 14 48.3	57.59	125.43	USZ	258.73	7.3	0.003	0.004	0.003	0.010	0.010	0.010
1988 1 2	18 54 34.3	57.16	122.25	TUG	47.95	6.6	---	---	0.005	0.080	0.004	0.023
1988 1 9	12 35 13.1	56.58	121.03	USZ	34.49	6.9	0.017	0.017	0.010	0.120	0.125	0.110
1988 1 9	12 35 13.1	56.58	121.03	TUG	81.49	8.1	0.022	0.022	0.023	0.088	0.112	0.118
1988 1 9	17 53 30.6	56.65	120.60	USZ	61.51	6.3	0.010	0.003	0.008	0.016	0.010	0.015
1988 111	20 50 42.9	56.68	120.70	USZ	56.17	5.4	---	---	0.003	0.010	0.009	0.006
1988 112	20 09 42.5	57.08	123.40	TUG	117.69	7.9	0.020	0.028	0.012	0.050	0.067	0.023
1988 130	15 57 24.2	56.60	121.02	USZ	35.27	6.7	0.034	0.012	0.024	0.100	0.034	0.090
1988 130	15 57 24.2	56.60	121.02	TUG	79.58	7.3	0.020	---	0.016	0.038	0.056	0.035
1988 2 4	22 00 58.5	57.00	124.63	CLNS	24.16	6.8	0.004	---	0.002	0.035	0.031	0.019
1988 2 9	17 31 28.1	56.60	121.06	USZ	32.84	8.6	0.100	0.120	0.125	1.000	0.300	0.840
1988 2 9	17 31 28.1	56.60	121.06	UURS	197.38	9.9	0.030	0.044	0.042	0.550	0.360	0.300
1988 2 9	17 31 28.1	56.60	121.06	CLNS	235.89	9.4	0.013	0.038	0.047	0.120	0.220	0.240
1988 2 9	17 31 28.1	56.60	121.06	KROS	444.27	9.2	---	0.005	0.008	0.020	0.083	0.013
1988 210	18 12 41.0	54.73	121.96	USZ	205.02	7.6	0.006	0.008	0.007	0.028	0.013	0.018
1988 224	18 40 34.6	57.13	123.44	CLNS	94.21	8.0	0.008	0.030	0.063	0.057	0.150	---
1988 224	18 40 34.6	57.13	123.44	TUG	119.14	8.3	0.023	---	0.025	0.180	0.110	0.091
1988 224	18 40 34.6	57.13	123.44	USZ	129.03	7.8	0.026	---	0.020	0.062	0.040	0.032
1988 3 9	13 23 47.8	56.94	127.95	KROS	285.91	7.8	0.005	---	0.012	0.012	0.043	0.017
1988 3 9	13 23 47.8	56.94	127.95	CGD	255.84	8.5	0.014	0.019	0.014	0.061	0.032	0.025
1988 3 9	20 14 38.8	57.23	127.90	CGD	232.91	7.2	0.005	0.005	0.004	0.011	0.010	0.005

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1988 318	20 13 54.1	56.98	122.66	USZ	80.07	6.4	0.007	---	0.003	0.011	0.006	0.008
1988 416	12 53 2.3	57.88	121.89	TUG	72.12	7.2	0.021	0.017	0.020	0.027	0.039	0.017
1988 416	12 53 2.3	57.88	121.89	USZ	147.82	7.5	0.005	0.006	0.008	0.030	0.016	0.016
1988 421	18 04 2.0	55.50	122.30	USZ	125.99	7.3	0.003	0.010	0.006	0.028	0.019	0.017
1988 423	20 29 44.2	57.56	128.37	CGD	186.85	7.5	0.004	0.005	0.004	0.025	0.021	0.005
1988 424	12 59 1.1	56.47	123.54	TUG	153.64	7.9	0.003	0.007	0.005	0.057	0.038	0.015
1988 424	16 23 26.9	57.00	124.83	USZ	203.30	9.7	0.102	0.038	0.078	0.356	0.236	0.259
1988 424	16 23 26.9	57.00	124.83	CLNS	18.25	8.0	0.267	0.243	0.797	1.233	1.280	1.261
1988 424	16 23 26.9	57.00	124.83	TUG	204.44	10.0	0.048	0.028	0.062	0.482	0.737	---
1988 424	16 23 26.9	57.00	124.83	UURS	213.91	8.9	0.020	0.004	0.006	0.138	0.129	0.108
1988 424	16 23 26.9	57.00	124.83	CGD	393.63	9.4	0.013	0.023	0.014	0.089	0.070	0.047
1988 424	16 23 26.9	57.00	124.83	KROS	316.29	8.7	0.026	0.010	0.028	0.038	0.056	0.037
1988 427	14 14 48.5	57.48	120.20	TUG	80.23	7.3	0.011	0.007	0.008	0.033	0.047	0.018
1988 427	14 14 48.5	57.48	120.20	USZ	132.47	7.6	0.004	0.006	0.009	0.046	0.028	0.019
1988 429	12 12 16.3	57.30	125.12	TUG	218.86	7.7	0.012	0.017	0.010	0.019	0.018	0.010
1988 5 1	15 27 4.4	57.42	123.18	TUG	103.41	7.9	0.011	0.022	0.017	0.049	0.036	0.017
1988 5 8	14 28 33.4	56.82	120.84	USZ	54.19	5.8	0.003	0.004	0.010	0.018	0.012	---
1990 110	16 29 4.0	57.02	122.22	KROS	414.79	10.8	0.140	0.110	0.150	0.410	0.740	---
1990 110	16 29 4.0	57.02	122.22	CGD	532.14	10.7	0.055	0.089	0.050	0.588	0.334	0.274
1999 129	16 45 16.6	57.32	120.75	USZ	98.67	10.6	0.374	0.305	0.417	1.084	0.749	1.135
1999 129	16 45 16.6	57.32	120.75	CLNS	256.49	11.2	0.286	0.715	0.474	1.672	1.581	1.762
1999 129	16 45 16.6	57.32	120.75	UURS	271.39	10.8	0.132	0.128	0.186	1.196	1.116	1.442
1999 129	16 45 16.6	57.32	120.75	KROS	504.47	11.9	0.058	0.058	0.083	0.520	0.520	---
1990 224	16 29 24.4	57.08	125.75	KROS	304.92	10.0	0.075	0.018	0.086	0.470	0.470	0.410
1990 224	16 29 24.4	57.08	125.75	CGD	342.25	10.4	0.113	0.231	0.147	0.786	0.676	0.245
1990 224	16 29 24.4	57.08	125.75	YAK	591.75	10.9	0.030	---	0.050	0.240	0.270	0.390

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1990 227	13 04 13.5	57.06	122.25	CGD	528.64	9.7	0.015	0.027	0.017	0.119	0.020	0.074
1990 227	13 04 13.5	57.06	122.25	CLNS	162.62	10.0	0.027	---	0.070	1.034	1.750	0.590
1990 227	13 04 13.5	57.06	122.25	KROS	416.44	9.7	0.029	0.008	0.004	0.190	0.032	0.190
1990 3 9	12 38 4.2	56.39	127.09	CLNS	143.09	8.8	0.019	---	0.040	0.218	0.258	0.198
1990 3 9	12 38 4.2	56.39	127.09	CGD	336.36	8.3	0.011	0.008	0.008	0.050	0.035	0.026
1990 319	14 34 18.4	53.14	131.66	KROS	339.07	8.6	0.008	0.018	0.019	0.084	0.038	0.055
1990 322	13 53 6.0	59.70	132.50	CGD	150.54	7.3	0.004	0.005	0.004	0.039	0.038	0.023
1990 414	12 16 29.6	57.60	133.72	CGD	222.48	8.5	0.021	0.011	0.014	0.111	0.090	0.066
1990 5 1	13 27 29.4	56.86	132.09	CGD	227.67	10.3	0.683	0.470	0.348	0.795	1.132	0.370
1990 5 1	13 27 29.4	56.86	132.09	KROS	419.29	10.3	0.087	0.130	0.150	0.420	0.200	0.190
1990 5 1	13 27 29.4	56.86	132.09	UURS	577.07	10.1	0.020	0.026	0.034	0.193	0.121	0.157
1990 5 1	13 27 29.4	56.86	132.09	YAK	589.39	11.4	0.137	0.085	0.286	0.464	0.833	0.528
1990 5 1	13 27 29.4	56.86	132.09	KHG	672.56	11.2	0.024	0.063	0.026	1.235	0.384	0.420
1990 5 1	13 27 29.4	56.86	132.09	USZ	641.27	10.8	0.012	0.034	0.023	0.465	0.211	0.215
1990 5 1	13 27 29.4	56.86	132.09	NZD	738.33	10.7	0.015	0.012	0.008	0.115	0.127	0.162
1990 5 1	14 40 30.0	56.90	132.00	CGD	221.51	8.2	0.036	0.016	0.027	0.040	0.080	0.014
1990 5 5	20 16 10.6	57.14	122.29	USZ	77.14	6.9	0.006	0.007	0.006	0.044	0.027	0.023
1990 513	14 03 1.2	57.05	122.25	USZ	67.56	6.4	0.005	0.004	0.006	0.027	0.018	0.015
1990 513	20 15 21.3	56.44	122.96	USZ	85.08	6.8	0.003	0.002	0.003	0.032	0.023	0.022
1990 513	22 50 8.2	56.61	122.61	USZ	62.62	8.2	0.021	0.032	0.022	0.219	0.221	0.308
1990 513	22 50 8.2	56.61	122.61	UURS	150.55	8.3	0.010	0.014	0.005	0.089	0.171	0.110
1990 517	18 37 36.4	56.52	121.19	UURS	185.43	10.5	0.165	0.116	0.311	0.952	0.925	1.053
1990 517	18 37 36.4	56.52	121.19	CLNS	229.47	10.8	0.088	0.159	0.269	0.992	1.106	0.569
1990 517	18 37 36.4	56.52	121.19	CGD	613.07	10.7	0.014	0.031	0.016	0.255	0.143	0.085
1990 517	18 37 36.4	56.52	121.19	YAK	777.55	12.0	0.014	0.020	0.020	0.646	0.429	0.330
1990 520	18 01 42.8	57.42	128.17	CGD	206.37	7.0	0.004	0.003	0.004	0.019	0.014	0.006

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1990 521	13 55 8.4	56.93	123.52	USZ	124.58	8.3	0.019	0.032	0.032	0.173	0.097	0.079
1990 521	13 55 8.4	56.93	123.52	CLNS	84.48	8.5	0.011	0.040	0.030	0.267	0.102	0.054
1990 521	13 55 8.4	56.93	123.52	UURS	182.31	8.8	0.019	0.009	0.027	0.113	0.203	0.191
1990 521	13 55 8.4	56.93	123.52	KROS	352.97	8.3	0.021	0.013	0.023	0.024	0.009	0.021
1990 525	14 50 24.3	57.04	122.17	USZ	63.87	7.2	0.008	0.016	0.017	0.096	0.055	0.044
1990 525	14 50 24.3	57.04	122.17	UURS	204.14	7.3	---	---	0.014	0.005	0.009	---
1990 526	19 01 9.0	57.55	126.00	CLNS	103.12	7.5	0.011	0.015	0.018	0.045	0.027	0.029
1990 526	19 01 9.0	57.55	126.00	USZ	288.44	7.7	0.003	0.003	0.003	0.024	0.021	0.024
1990 529	14 52 33.2	56.50	123.92	USZ	143.01	7.5	0.008	0.007	0.005	0.046	0.046	0.035
1990 529	14 52 33.2	56.50	123.92	UURS	140.52	7.5	0.005	0.005	0.006	0.031	0.044	0.042
1990 531	14 43 46.4	56.05	123.86	UURS	92.69	7.3	0.003	0.003	0.005	0.023	0.041	0.027
1990 531	14 43 46.4	56.05	123.86	USZ	151.09	7.7	0.005	0.004	0.003	0.065	0.053	0.033
1990 6 2	17 11 19.7	55.65	130.66	CGD	344.89	11.4	0.310	0.137	0.066	1.454	1.098	0.887
1990 6 2	17 11 19.7	55.65	130.66	CLNS	379.73	11.3	0.286	0.186	0.390	1.284	1.247	1.346
1990 6 2	17 11 19.7	55.65	130.66	USZ	571.22	11.3	0.077	0.154	0.188	1.040	0.606	0.885
1990 6 2	17 11 19.7	55.65	130.66	KHG	826.77	12.2	0.025	0.017	0.055	0.993	0.718	0.630
1990 6 2	17 11 19.7	55.65	130.66	YAK	710.34	12.6	0.087	0.024	0.137	2.650	2.100	2.065
1990 6 2	17 11 19.7	55.65	130.66	NZD	898.87	12.0	0.025	0.017	0.023	0.424	0.221	0.324
1990 6 3	12 16 44.3	57.46	121.53	USZ	100.07	7.5	0.003	0.003	0.004	0.051	0.044	0.044
1990 6 3	12 16 44.3	57.46	121.53	UURS	261.78	7.0	0.004	0.004	0.004	0.006	0.006	0.017
1990 6 5	13 00 1.3	57.11	122.00	USZ	65.91	8.6	0.044	0.057	0.072	0.266	0.300	0.319
1990 6 7	14 04 31.3	57.07	122.21	USZ	68.00	7.4	0.008	0.007	0.012	0.095	0.095	0.066
1990 612	18 03 14.0	57.50	128.30	CLNS	217.79	8.7	0.012	0.018	0.023	0.125	0.149	0.091
1990 612	18 03 14.0	57.50	128.30	KROS	351.40	8.7	0.013	0.003	0.013	0.064	0.055	0.036
1990 612	18 03 14.0	57.50	128.30	UURS	397.12	8.7	0.015	0.012	0.010	0.036	0.038	0.058
1990 614	18 46 35.0	57.10	122.40	USZ	77.57	6.2	0.003	0.003	0.003	0.011	0.012	0.011

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1990 614	19 33 48.1	57.32	124.08	USZ	172.99	7.2	0.005	0.005	0.005	0.021	0.023	0.015
1990 616	15 39 11.2	57.08	122.17	USZ	67.60	6.7	0.007	0.007	0.007	0.034	0.032	0.022
1990 616	15 39 11.2	57.08	122.17	UURS	208.35	6.8	---	---	0.005	0.014	0.007	0.014
1990 618	17 52 3.3	57.04	122.18	TUG	49.37	7.5	0.068	0.055	0.054	0.208	0.163	0.161
1990 618	17 52 3.3	57.04	122.18	USZ	64.21	7.0	0.007	0.014	0.014	0.059	0.069	0.051
1990 618	17 52 3.3	57.04	122.18	UURS	203.94	7.5	0.009	0.004	0.010	0.027	0.021	0.030
1990 620	13 49 32.4	54.12	121.12	UURS	188.12	7.9	0.009	0.009	0.029	0.041	0.068	0.060
1990 620	13 49 32.4	54.12	121.12	USZ	273.20	8.2	0.015	0.010	0.020	0.038	0.057	0.068
1990 620	17 14 12.0	56.55	121.14	USZ	27.69	5.6	0.007	0.014	0.004	0.030	0.020	0.020
1990 621	17 33 21.1	57.06	122.18	TUG	48.25	8.6	0.120	0.140	0.180	0.830	0.630	0.630
1990 621	17 33 21.1	57.06	122.18	USZ	66.06	8.5	0.110	0.110	0.140	0.323	0.332	0.230
1990 621	17 33 21.1	57.06	122.18	CLNS	166.82	9.0	0.006	0.014	0.048	0.353	0.442	0.154
1990 621	17 33 21.1	57.06	122.18	UURS	206.04	8.3	0.004	0.004	0.015	0.070	0.068	0.087
1990 625	13 22 54.7	55.81	121.73	USZ	84.00	8.0	0.040	0.010	0.052	0.073	0.177	0.050
1990 625	13 22 54.7	55.81	121.73	UURS	109.41	8.2	0.004	0.016	0.030	0.170	0.020	0.168
1990 629	12 30 10.1	56.72	124.04	CLNS	54.08	7.2	0.007	0.011	0.020	0.106	0.101	0.050
1990 629	12 30 10.1	56.72	124.04	USZ	150.82	8.2	0.013	0.025	0.018	0.085	0.087	0.103
1990 629	12 30 10.1	56.72	124.04	UURS	166.07	7.3	0.011	0.003	0.008	0.046	0.090	0.121
1990 630	18 35 3.5	57.10	122.19	USZ	70.16	8.2	0.087	0.055	0.078	0.227	0.177	0.145
1990 630	18 35 3.5	57.10	122.19	CLNS	166.85	8.5	---	---	0.012	0.113	0.157	---
1990 630	18 35 3.5	57.10	122.19	UURS	210.08	7.9	---	---	0.006	0.041	0.041	---
1990 8 3	14 02 8.4	57.54	127.81	CLNS	191.91	9.9	0.026	0.044	0.020	0.300	0.655	0.296
1990 8 3	14 02 8.4	57.54	127.81	CGD	212.75	9.8	0.044	0.108	0.104	0.310	0.284	0.142
1990 8 3	14 02 8.4	57.54	127.81	UURS	376.66	8.6	0.010	0.007	0.015	0.040	0.027	0.060
1990 8 3	14 02 8.4	57.54	127.81	USZ	391.55	8.9	0.003	0.010	0.007	0.059	0.030	0.043
1991 115	16 15 47.7	57.09	122.26	USZ	71.54	8.6	0.072	0.044	0.037	0.248	0.386	0.341

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 115	16 15 47.7	57.09	122.26	TNL	551.34	8.5	0.117	0.071	0.096	0.666	0.686	0.369
1991 115	16 15 47.7	57.09	122.26	UURS	207.75	8.3	0.008	0.008	0.014	0.041	0.056	0.128
1991 123	21 24 5.3	57.06	122.24	UURS	204.92	9.9	0.034	0.065	0.066	0.470	0.500	0.736
1991 123	21 24 5.3	57.06	122.24	CGD	529.20	10.5	0.080	0.056	0.047	0.315	0.278	0.277
1991 311	19 47 51.3	56.13	127.03	CLNS	152.83	8.6	0.033	0.034	0.085	0.153	0.184	0.109
1991 311	19 47 51.3	56.13	127.03	UURS	256.15	8.5	0.010	0.010	0.014	0.108	0.077	0.080
1991 311	19 47 51.3	56.13	127.03	CGD	361.93	8.4	0.006	0.006	0.010	0.056	0.043	0.014
1991 311	19 47 51.3	56.13	127.03	USZ	338.61	8.0	0.006	0.007	0.007	0.030	0.016	0.023
1991 311	19 47 51.3	56.13	127.03	KROS	189.33	8.2	0.004	---	0.005	0.100	0.054	0.067
1991 516	14 12 46.7	56.50	124.88	CLNS	37.82	9.0	0.233	0.295	0.447	1.547	1.415	0.969
1991 516	14 12 46.7	56.50	124.88	USZ	201.85	8.8	0.012	0.019	0.020	0.149	0.100	0.187
1991 516	14 12 46.7	56.50	124.88	TUG	223.67	9.5	---	0.017	0.017	0.210	0.333	0.259
1991 516	14 12 46.7	56.50	124.88	KROS	265.89	8.2	0.024	0.011	0.030	0.052	0.023	0.019
1991 716	15 10 26.1	56.59	120.98	USZ	37.58	8.2	0.053	0.085	0.115	0.645	0.616	0.702
1991 716	15 10 26.1	56.59	120.98	TUG	81.49	8.7	0.083	0.072	0.099	0.229	0.290	0.156
1991 716	15 10 26.1	56.59	120.98	UURS	200.01	8.7	0.010	0.015	0.019	0.148	0.097	0.197
1991 716	15 10 26.1	56.59	120.98	KROS	447.94	8.3	---	0.020	0.003	0.015	0.029	0.021
1991 716	18 40 57.6	57.80	132.87	CGD	168.94	10.0	0.144	0.156	0.300	0.789	0.973	0.875
1991 716	18 40 57.6	57.80	132.87	KROS	523.11	9.5	0.008	0.009	0.011	0.034	0.066	0.053
1991 722	12 05 27.3	55.79	131.11	KROS	303.09	9.8	0.061	0.081	0.100	0.466	0.180	0.210
1991 722	12 05 27.3	55.79	131.11	CGD	330.63	10.0	0.140	0.073	0.068	0.144	0.666	0.106
1991 722	12 05 27.3	55.79	131.11	UURS	499.52	10.0	0.017	0.050	0.071	0.230	0.176	0.152
1991 722	12 05 27.3	55.79	131.11	USZ	595.16	9.7	0.025	0.018	0.011	0.105	0.071	0.096
1991 724	18 47 4.7	57.13	122.21	USZ	73.61	8.0	0.026	0.027	0.029	0.242	0.116	0.120
1991 730	12 36 20.8	55.36	124.41	KROS	194.53	8.4	0.011	0.017	0.020	0.160	0.076	0.050
1991 730	12 36 20.8	55.36	124.41	USZ	220.56	8.2	0.007	0.006	0.007	0.066	0.045	0.010

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 730	12 36 20.8	55.36	124.41	UURS	75.81	8.4	0.015	0.041	0.031	0.397	0.285	0.228
1991 819	19 19 13.5	55.77	130.16	KROS	251.29	8.2	0.008	0.013	0.015	0.031	0.061	0.054
1991 9 2	12 05 14.4	57.12	122.26	USZ	74.31	8.7	0.039	0.068	0.058	0.615	0.350	0.261
1991 9 5	17 50 40.0	56.60	122.10	USZ	31.42	6.3	0.026	0.027	0.029	0.071	0.085	0.033
1991 9 6	18 28 2.3	57.16	122.05	USZ	72.24	7.8	0.055	0.024	0.015	0.153	0.133	0.080
1991 9 6	18 28 2.3	57.16	122.05	UURS	219.14	7.8	0.011	0.007	0.009	0.015	0.017	0.019
1991 918	18 13 44.0	57.00	122.07	USZ	56.88	7.0	0.030	0.042	0.043	0.094	0.119	0.051
1991 918	18 13 44.0	57.00	122.07	TUG	46.60	7.6	0.093	0.057	0.043	0.370	0.108	0.136
19911022	12 19 2.0	57.09	122.07	TUG	40.84	8.7	0.110	0.150	0.040	0.820	0.910	0.620
19911022	12 19 2.0	57.09	122.07	USZ	65.66	9.0	0.194	0.212	0.222	0.584	0.529	0.773
19911022	12 19 2.0	57.09	122.07	UURS	211.40	8.8	0.024	0.036	0.027	0.167	0.153	0.146
19911111	19 10 13.7	56.18	124.14	CLNS	87.00	9.3	0.054	0.063	0.075	0.878	0.700	0.313
19911111	19 10 13.7	56.18	124.14	USZ	162.63	9.0	0.028	0.030	0.040	0.265	0.213	0.285
19911111	19 10 13.7	56.18	124.14	UURS	113.72	8.8	0.041	0.041	0.040	0.169	0.307	0.171
19911111	19 10 13.7	56.18	124.14	KROS	265.28	8.8	0.014	0.018	0.029	0.057	0.140	0.100
19911123	19 28 52.0	55.43	124.00	USZ	195.65	7.2	0.010	0.010	0.007	0.015	0.010	0.010
19911123	19 28 52.0	55.43	124.00	UURS	51.59	6.5	0.015	0.019	0.005	0.031	0.031	0.016
199112 1	19 23 31.3	53.89	126.73	KROS	62.12	8.8	0.028	0.014	0.038	0.750	0.600	0.480
199112 1	19 23 31.3	53.89	126.73	UURS	275.42	8.7	0.013	0.020	0.018	0.064	0.070	0.075
199112 1	19 23 31.3	53.89	126.73	USZ	440.93	9.2	0.010	0.010	0.010	0.065	0.076	0.057
199112 2	17 18 34.5	56.80	123.83	USZ	139.34	7.2	0.003	0.005	0.004	0.032	0.034	0.035
199112 2	17 18 34.5	56.80	123.83	UURS	171.16	7.5	0.006	0.009	0.008	0.021	0.047	0.033
199112 2	19 47 16.1	57.50	126.70	USZ	326.33	8.8	0.011	0.008	0.005	0.085	0.080	0.061
199112 2	19 47 16.1	57.50	126.70	UURS	325.33	8.4	0.011	0.015	0.010	0.030	0.059	0.033
199112 2	19 47 16.1	57.50	126.70	CLNS	131.06	8.8	0.022	0.018	0.023	0.318	0.195	0.180
199112 3	15 36 18.9	57.04	122.11	USZ	61.93	8.0	0.029	0.041	0.043	0.192	0.296	0.130

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 12 3	15 36 18.9	57.04	122.11	UURS	205.35	7.7	0.004	0.005	0.011	0.031	0.024	0.040
19911225	14 53 4.2	56.79	123.91	CLNS	60.54	6.8	0.008	0.007	0.026	0.045	0.057	0.032
1994 8 7	20 50 26.5	57.46	128.13	CGD	204.82	7.0	---	---	0.004	0.015	0.011	---
1996 212	18 56 59.9	57.52	120.77	CGD	593.68	11.6	0.108	0.216	0.090	1.081	1.289	0.615
1996 9 4	12 56 31.3	57.55	128.03	CGD	202.17	8.4	---	---	0.011	0.102	0.092	---
1996 9 4	12 56 31.3	57.55	128.03	KROS	353.33	8.0	---	---	0.001	0.020	0.043	0.017
1997 2 1	20 39 18.4	54.28	124.82	KROS	141.22	9.0	0.021	0.052	0.068	0.340	0.210	0.310
1997 2 1	20 39 18.4	54.28	124.82	UURS	153.14	9.3	0.103	0.137	0.169	0.227	0.282	0.357
1997 2 1	20 39 18.4	54.28	124.82	CLNS	284.85	9.1	0.012	0.009	0.015	0.223	0.181	0.090
1997 325	20 48 48.2	56.56	121.04	USZ	33.78	7.3	0.144	0.172	0.333	0.537	0.305	0.389
1997 325	20 48 48.2	56.56	121.04	UURS	195.05	9.0	0.014	0.021	0.036	0.120	0.202	0.201
1997 325	20 48 48.2	56.56	121.04	CLNS	237.79	8.4	0.018	0.022	0.027	0.082	0.083	0.052
1997 5 1	20 01 13.7	57.08	129.80	CGD	191.94	9.2	0.048	0.043	0.029	0.274	0.382	0.130
1997 5 1	20 01 13.7	57.08	129.80	CLNS	298.35	9.3	0.021	0.021	0.030	0.316	0.166	0.157
1997 5 1	20 01 13.7	57.08	129.80	KROS	343.62	9.0	0.018	0.013	0.023	0.077	0.140	0.100
1997 510	14 33 0.5	54.25	122.84	USZ	268.92	9.7	0.036	0.029	0.124	0.211	0.269	0.268
1997 510	14 33 0.5	54.25	122.84	KROS	269.41	9.1	0.008	0.039	0.041	0.140	0.150	0.120
1997 510	14 33 0.5	54.25	122.84	CLNS	315.94	10.0	0.018	0.018	0.018	0.396	0.488	0.407
1997 710	19 12 25.5	56.05	126.36	CLNS	125.63	9.0	0.033	0.015	0.030	0.352	0.377	0.184
1997 710	19 12 25.5	56.05	126.36	KROS	184.70	9.2	0.020	---	0.019	0.320	0.140	0.210
1997 710	19 12 25.5	56.05	126.36	USZ	299.67	8.3	0.007	0.010	0.011	0.058	0.031	0.056
1997 8 5	20 00 20.6	56.27	123.11	USZ	98.89	8.2	0.019	0.013	0.017	0.144	0.115	0.133
1997 8 5	20 00 20.6	56.27	123.11	UURS	108.11	8.3	0.043	0.012	0.069	0.081	0.067	0.143
1997 8 5	20 00 20.6	56.27	123.11	CLNS	126.75	8.2	0.015	0.018	0.027	0.151	0.090	0.048
1997 811	17 54 37.1	58.34	121.67	USZ	197.95	8.9	0.077	0.029	0.094	0.125	0.128	0.103
1997 811	17 54 37.1	58.34	121.67	CLNS	254.78	9.0	0.015	0.011	0.011	0.262	0.247	0.105

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1997 811	17 54 37.1	58.34	121.67	UURS	351.04	8.9	0.026	0.012	0.008	0.038	0.072	0.097
1997 811	17 54 37.1	58.34	121.67	KROS	544.14	8.6	---	---	0.002	0.008	0.028	---
1997 811	17 54 37.1	58.34	121.67	CGD	520.99	8.8	0.006	0.007	0.007	0.057	0.050	0.019
1997 824	13 39 56.9	57.60	128.08	CGD	196.23	7.0	---	---	0.003	0.014	0.013	---
199711 6	19 50 29.6	57.40	120.66	UURS	281.78	10.5	0.299	0.406	0.350	1.520	1.130	1.408
199711 6	19 50 29.6	57.40	120.66	CLNS	263.50	10.9	0.699	0.717	1.069	1.355	1.700	1.670
199711 6	19 50 29.6	57.40	120.66	CGD	604.07	11.8	0.105	0.144	0.120	1.600	1.150	1.290
199711 6	19 50 29.6	57.40	120.66	YAK	719.69	11.0	0.165	0.240	0.335	2.575	2.600	2.115
1999 2 3	19 39 28.2	57.36	120.71	USZ	103.72	10.3	0.560	0.550	0.650	1.160	2.020	1.440
1999 2 3	19 39 28.2	57.36	120.71	CLNS	259.67	11.2	0.100	0.470	0.350	2.030	2.320	2.020
1999 2 3	19 39 28.2	57.36	120.71	UURS	276.41	10.7	0.190	0.260	0.286	1.040	1.660	1.250
1999 2 3	19 39 28.2	57.36	120.71	CGD	602.66	11.2	0.036	0.050	0.030	0.730	0.530	0.450

Explosions in the Southern Yakutia Region

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 1 3	08 21 51.4	58.95	125.57	TUG	304.40	7.5	0.005	0.011	0.006	0.021	0.022	0.011
1986 1 3	08 21 51.4	58.95	125.57	CLNS	238.05	7.5	0.020	0.007	0.025	0.040	0.030	0.025
1986 1 3	08 21 51.4	58.95	125.57	CGD	291.21	8.4	0.007	0.008	0.014	0.058	0.030	0.027
1986 1 4	06 57 08.5	58.94	125.61	TUG	305.61	7.7	0.005	0.011	0.011	0.021	0.022	0.023
1986 1 4	06 57 08.5	58.94	125.61	CLNS	237.36	8.2	0.040	0.007	0.025	0.059	0.027	0.051
1986 1 4	06 57 08.5	58.94	125.61	USZ	356.17	7.5	0.007	0.003	0.003	0.014	0.013	0.006
1986 1 6	06 32 16.3	59.06	125.59	TUG	312.67	8.3	0.011	0.011	0.011	0.043	0.044	0.054
1986 1 6	06 32 16.3	59.06	125.59	CGD	290.79	9.0	0.029	0.027	0.030	0.144	0.054	0.060
1986 1 7	05 39 11.1	58.89	125.63	CGD	287.57	8.5	0.029	0.041	0.061	0.072	0.054	0.061
1986 1 7	05 39 11.1	58.89	125.63	TUG	303.34	7.5	---	0.005	0.006	0.011	0.011	0.006
1986 1 8	06 24 48.5	58.88	125.77	CGD	279.51	8.8	0.021	0.068	0.015	0.032	0.103	0.030
1986 1 9	05 12 34.0	56.77	124.72	USZ	192.64	10.1	0.149	0.303	0.291	0.500	0.316	0.514
1986 1 9	05 12 34.0	56.77	124.72	TUG	203.92	9.6	0.086	0.111	0.158	0.215	0.266	0.304
1986 1 9	05 12 34.0	56.77	124.72	UURS	188.33	10.1	0.181	0.034	0.184	0.480	0.513	0.214
1986 1 9	05 12 34.0	56.77	124.72	CGD	413.29	10.0	0.029	0.041	0.030	0.274	0.081	0.076
1986 1 9	08 26 58.7	56.74	124.91	CLNS	11.02	5.9	0.119	0.040	0.051	0.355	0.135	0.228
1986 1 9	08 26 58.7	56.74	124.91	TUG	215.97	6.8	0.005	---	0.006	0.011	0.011	0.011
1986 1 9	08 26 58.7	56.74	124.91	UURS	191.70	7.5	0.005	0.008	0.015	0.005	0.017	0.015
1986 114	03 23 01.7	56.75	125.21	CLNS	21.30	7.0	0.045	0.148	0.126	0.317	0.349	0.354
1986 114	07 23 07.7	59.00	125.68	CLNS	244.67	8.8	0.046	0.016	0.038	0.111	0.070	0.066
1986 114	07 23 07.7	59.00	125.68	CGD	285.18	9.1	---	0.016	0.061	0.187	0.103	0.115
1986 114	07 23 07.7	59.00	125.68	KROS	514.76	8.3	0.003	---	0.005	0.020	0.020	0.007
1986 115	07 04 31.7	56.80	124.72	USZ	193.00	8.5	0.040	0.050	0.045	0.068	0.046	0.088
1986 115	07 04 31.7	56.80	124.72	UURS	191.22	8.5	0.027	---	0.046	0.037	0.103	0.061

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 115	07 04 31.7	56.80	124.72	CLNS	11.81	6.5	0.119	0.108	0.177	0.553	0.296	0.607
1986 115	07 04 31.7	56.80	124.72	CGD	411.40	8.5	0.007	0.014	0.008	0.036	0.020	0.015
1986 115	07 04 31.7	56.80	124.72	TUG	202.96	8.6	0.032	0.044	0.039	0.064	0.056	0.067
1986 118	05 03 15.7	56.58	127.90	KROS	246.24	9.3	0.005	0.020	0.050	0.023	0.180	0.200
1986 118	05 03 15.7	56.58	127.90	USZ	386.50	10.6	0.176	0.278	0.257	0.392	0.303	0.413
1986 118	05 03 15.7	56.58	127.90	UURS	324.60	10.6	0.139	0.034	0.092	0.288	0.718	0.367
1986 118	05 03 15.7	56.58	127.90	CGD	290.49	9.0	---	---	0.045	0.216	0.136	---
1986 118	05 03 15.7	56.58	127.90	TUG	397.11	10.5	0.150	0.155	0.225	0.192	0.288	0.349
1986 121	05 25 43.7	58.92	125.61	CGD	288.79	8.5	0.014	0.020	0.012	0.040	0.046	0.024
1986 122	03 08 33.5	56.89	125.21	CLNS	19.67	7.0	0.119	0.067	0.040	0.553	0.283	---
1986 122	03 08 33.5	56.89	125.21	USZ	223.84	7.4	0.007	0.006	0.006	0.020	0.020	0.025
1986 122	03 08 33.5	56.89	125.21	UURS	215.83	7.9	0.021	0.017	0.015	0.021	0.034	0.046
1986 122	03 08 33.5	56.89	125.21	TUG	229.42	7.0	---	---	0.006	0.021	0.022	0.017
1986 123	06 47 48.8	56.83	124.72	USZ	193.40	9.4	0.216	0.076	0.190	0.176	0.114	0.134
1986 123	06 47 48.8	56.83	124.72	UURS	194.13	8.9	---	---	0.050	0.080	0.200	---
1986 123	06 47 48.8	56.83	124.72	CGD	409.53	9.6	0.022	0.041	0.030	0.115	0.081	0.045
1986 123	06 47 48.8	56.83	124.72	KROS	302.61	8.7	---	0.020	0.040	0.036	0.082	0.050
1986 123	06 47 48.8	56.83	124.72	TUG	202.04	9.3	0.064	0.111	0.079	0.128	0.177	0.124
1986 124	05 32 10.8	56.79	124.96	USZ	207.42	8.8	0.047	0.076	0.078	0.189	0.088	0.078
1986 124	05 32 10.8	56.79	124.96	UURS	198.01	7.7	0.064	0.034	0.092	0.053	0.085	0.122
1986 124	05 32 10.8	56.79	124.96	TUG	217.32	8.5	0.032	0.044	0.045	0.064	0.089	0.079
1986 124	05 32 10.8	56.79	124.96	CGD	400.03	8.7	0.022	---	0.008	0.029	0.041	0.023
1986 211	07 38 35.1	56.80	124.70	USZ	191.79	7.9	0.007	0.012	0.011	0.041	0.025	0.022
1986 211	07 38 35.1	56.80	124.70	CLNS	12.95	5.4	0.020	0.020	0.013	0.119	0.094	0.126
1986 211	07 38 35.1	56.80	124.70	TUG	201.80	8.0	0.011	0.011	0.011	0.043	0.022	0.011
1986 211	07 38 35.1	56.80	124.70	UURS	190.61	7.5	0.011	---	0.007	0.016	0.034	0.015

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 212	03 37 18.1	56.64	125.02	USZ	210.11	9.8	0.041	0.134	0.111	0.351	0.253	0.145
1986 212	03 37 18.1	56.64	125.02	TUG	225.87	9.3	0.064	0.044	0.079	0.150	0.133	0.192
1986 212	03 37 18.1	56.64	125.02	UURS	186.62	8.7	0.043	0.061	0.017	0.107	0.092	0.103
1986 212	04 43 48.7	56.80	125.22	USZ	223.29	9.3	0.027	0.074	0.067	0.176	0.164	0.156
1986 212	04 43 48.7	56.80	125.22	TUG	232.33	8.7	0.043	0.022	0.045	0.064	0.067	0.101
1986 212	04 43 48.7	56.80	125.22	UURS	208.15	8.7	0.032	0.008	0.031	0.064	0.103	0.061
1986 212	04 43 48.7	56.80	125.22	CGD	386.55	8.7	0.007	0.014	0.008	0.058	0.027	0.045
1986 212	07 43 41.2	56.86	125.09	USZ	216.16	8.9	0.027	0.060	0.067	0.095	0.074	0.067
1986 212	07 43 41.2	56.86	125.09	TUG	223.04	8.6	0.021	0.044	0.034	0.064	0.066	0.056
1986 212	07 43 41.2	56.86	125.09	UURS	208.89	8.7	0.032	0.008	0.031	0.043	0.103	0.092
1986 212	07 43 41.2	56.86	125.09	CGD	389.08	8.7	0.007	0.007	0.004	0.043	0.041	0.030
1986 212	08 36 13.2	56.80	125.08	USZ	214.80	8.7	0.014	0.030	0.022	0.108	0.074	0.056
1986 212	08 36 13.2	56.80	125.08	UURS	203.08	8.0	0.032	0.008	0.015	0.021	0.034	0.061
1986 212	08 36 13.2	56.80	125.08	CGD	393.44	8.4	0.007	0.007	0.008	0.029	0.014	0.014
1986 213	06 00 37.8	58.43	126.00	CGD	269.97	9.0	0.029	0.027	0.015	0.130	0.204	0.152
1986 213	08 29 16.2	58.89	125.52	CGD	293.90	9.7	0.086	0.109	0.076	0.273	0.204	0.273
1986 213	08 29 16.2	58.89	125.52	USZ	348.57	8.0	0.007	0.007	0.003	0.027	0.015	0.011
1986 214	03 04 54.1	56.67	124.97	USZ	207.14	8.4	0.041	0.025	0.034	0.054	0.038	0.022
1986 214	03 04 54.1	56.67	124.97	TUG	221.88	8.5	0.021	0.022	0.034	0.042	0.044	0.034
1986 214	03 04 54.1	56.67	124.97	UURS	187.44	8.5	0.021	0.008	0.031	0.082	0.051	0.046
1986 214	07 11 00.0	56.67	124.97	CLNS	19.34	9.0	0.040	0.027	0.037	0.198	0.108	0.076
1986 214	07 11 00.0	56.67	124.97	TUG	221.88	8.4	0.011	0.011	0.023	0.043	0.044	0.045
1986 214	07 11 00.0	56.67	124.97	UURS	187.44	8.0	0.011	0.008	0.015	0.011	0.017	0.031
1986 214	07 11 00.0	56.67	124.97	CGD	407.42	8.4	0.058	0.054	0.045	0.144	0.109	0.076
1986 215	03 12 26.4	57.34	126.29	USZ	297.87	8.0	---	0.025	0.006	0.027	0.019	0.022
1986 215	03 12 26.4	57.34	126.29	TUG	289.09	8.0	0.005	0.005	0.011	0.021	0.022	0.025

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 215	03 12 26.4	57.34	126.29	UURS	295.67	8.4	0.021	0.008	0.031	0.021	0.034	0.031
1986 215	06 07 41.4	58.89	125.72	USZ	356.62	8.0	0.003	0.003	0.003	0.027	0.013	0.011
1986 215	06 07 41.4	58.89	125.72	CLNS	233.16	8.2	0.020	0.013	0.025	0.049	0.081	0.038
1986 215	06 07 41.4	58.89	125.72	TUG	307.61	8.2	0.005	0.005	0.011	0.043	0.033	0.034
1986 215	06 07 41.4	58.89	125.72	CGD	282.40	9.2	0.072	0.041	0.030	0.187	0.176	0.091
1986 215	06 16 00.3	56.72	125.15	USZ	218.38	8.2	0.014	0.019	0.017	0.054	0.025	0.022
1986 215	06 16 00.3	56.72	125.15	TUG	230.63	8.1	0.011	0.011	0.023	0.032	0.022	0.023
1986 215	06 16 00.3	56.72	125.15	UURS	198.52	8.5	0.021	0.008	0.031	0.051	0.068	0.061
1986 215	09 11 54.3	56.83	124.96	USZ	207.90	7.5	0.003	0.003	0.003	0.027	0.006	0.011
1986 215	09 11 54.3	56.83	124.96	TUG	216.15	6.5	---	---	0.003	0.005	0.011	0.006
1986 221	05 34 09.5	58.97	125.67	CGD	285.57	9.1	0.040	0.030	0.050	0.170	0.090	0.120
1986 221	05 34 09.5	58.97	125.67	CLNS	241.29	8.6	0.032	0.030	0.025	0.090	0.060	0.072
1986 3 1	03 05 11.6	56.42	125.12	USZ	217.25	8.4	0.020	0.037	0.033	0.081	0.050	0.044
1986 3 1	03 05 11.6	56.42	125.12	CLNS	48.64	7.8	0.495	0.296	0.050	2.272	1.354	0.810
1986 3 1	03 05 11.6	56.42	125.12	UURS	172.17	8.4	0.042	---	0.046	0.032	0.068	0.061
1986 3 1	03 10 30.5	57.00	125.00	USZ	213.37	10.3	0.027	0.075	0.078	0.081	0.063	0.055
1986 3 1	03 10 30.5	57.00	125.00	CLNS	18.75	5.4	0.165	0.148	0.164	1.033	1.482	0.708
1986 3 1	03 10 30.5	57.00	125.00	TUG	214.60	8.5	0.033	0.044	0.045	0.042	0.033	0.067
1986 3 1	03 10 30.5	57.00	125.00	UURS	219.03	8.4	0.042	---	0.046	0.021	0.051	0.046
1986 3 1	05 15 30.0	56.66	125.34	TUG	243.70	9.7	0.042	0.177	0.191	0.150	0.222	0.406
1986 3 1	05 15 30.0	56.66	125.34	UURS	200.88	9.9	0.256	0.051	0.245	0.459	0.650	0.521
1986 3 1	05 15 30.0	56.66	125.34	CGD	390.24	9.2	0.043	0.040	0.030	0.303	0.163	0.151
1986 3 4	05 35 03.3	58.94	125.69	CGD	284.28	9.3	0.072	0.040	0.060	0.158	0.122	0.106
1986 3 4	05 35 03.3	58.94	125.69	UURS	431.55	8.3	0.005	---	0.009	0.005	0.027	0.009
1986 3 4	05 35 03.3	58.94	125.69	TUG	309.36	7.0	0.005	---	0.015	0.010	0.011	0.011
1986 3 5	06 57 49.7	56.34	125.12	USZ	218.30	7.8	0.013	---	0.022	0.040	0.012	0.016

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 3 5	06 57 49.7	56.34	125.12	CLNS	57.22	7.7	0.019	0.040	0.063	0.119	0.067	0.101
1986 3 5	06 57 49.7	56.34	125.12	TUG	244.62	7.3	0.010	0.011	0.005	0.010	0.011	0.011
1986 3 7	04 47 02.8	57.00	125.00	TUG	214.60	8.4	0.021	0.033	0.045	0.032	0.066	0.045
1986 3 7	04 47 02.8	57.00	125.00	UURS	219.03	8.7	0.042	0.010	0.046	0.021	0.034	0.046
1986 3 7	04 47 02.8	57.00	125.00	CGD	384.93	8.5	0.004	0.004	0.004	0.043	0.013	0.007
1986 3 7	05 20 03.0	56.71	124.81	USZ	197.59	9.6	0.087	0.164	0.167	0.283	0.178	0.234
1986 3 7	05 20 03.0	56.71	124.81	TUG	211.19	9.3	0.064	0.111	0.146	0.085	0.133	0.169
1986 3 7	05 20 03.0	56.71	124.81	UURS	185.53	8.9	0.128	0.017	0.122	0.138	0.239	0.153
1986 3 7	05 20 03.0	56.71	124.81	CGD	412.65	9.9	0.021	0.040	0.022	0.260	0.061	0.075
1986 3 7	07 01 24.7	58.87	125.67	USZ	353.02	8.0	0.006	0.007	0.005	0.027	0.022	0.016
1986 3 7	07 01 24.7	58.87	125.67	CLNS	230.39	8.5	0.039	0.013	0.025	0.099	0.094	0.075
1986 3 7	07 01 24.7	58.87	125.67	TUG	303.99	8.0	0.006	0.011	0.011	0.021	0.022	0.033
1986 3 7	07 01 24.7	58.87	125.67	CGD	285.25	9.2	0.115	0.113	0.075	0.176	0.163	0.090
1986 3 8	03 08 14.9	56.82	124.90	USZ	204.14	7.7	0.006	0.006	0.016	0.033	0.012	0.016
1986 3 8	03 08 14.9	56.82	124.90	TUG	212.92	7.6	0.006	0.006	0.005	0.021	0.022	0.016
1986 3 9	06 10 22.2	56.82	125.00	CLNS	6.47	6.4	0.079	0.040	0.003	1.190	0.862	---
1986 3 9	06 10 22.2	56.82	125.00	USZ	210.19	8.0	0.006	0.007	0.021	0.027	0.029	0.033
1986 3 9	06 10 22.2	56.82	125.00	TUG	218.80	7.5	0.006	0.011	0.005	0.010	0.022	0.022
1986 3 9	06 10 22.2	56.82	125.00	UURS	202.14	8.3	0.010	0.010	0.030	0.021	0.051	0.030
1986 4 3	05 52 34.5	58.94	125.35	USZ	346.04	8.8	0.013	0.007	0.005	0.067	0.044	0.033
1986 4 3	05 52 34.5	58.94	125.35	TUG	293.63	8.4	0.010	0.022	0.016	0.064	0.044	0.050
1986 4 3	05 52 34.5	58.94	125.35	CGD	303.79	10.2	0.016	---	0.030	0.245	0.149	0.090
1986 4 4	05 46 58.4	57.76	124.70	TUG	199.94	9.3	0.085	0.255	0.112	0.085	0.155	0.090
1986 4 4	05 46 58.4	57.76	124.70	USZ	230.09	10.0	0.114	0.312	0.290	0.310	0.208	0.227
1986 4 5	04 05 04.1	58.88	125.51	CGD	294.45	8.6	0.021	0.040	0.022	0.075	0.054	0.113
1986 422	04 06 35.6	56.62	125.00	KROS	273.92	9.4	---	---	0.021	0.219	0.074	0.155

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 7 2	04 07 51.1	56.89	124.74	CLNS	11.23	7.2	0.051	0.048	0.073	1.877	0.996	0.808
1986 7 2	04 07 51.1	56.89	124.74	USZ	195.61	9.0	0.040	0.095	0.057	0.092	0.129	0.154
1986 7 2	04 07 51.1	56.89	124.74	TUG	201.56	9.0	0.010	0.043	0.046	0.106	0.142	0.105
1986 7 2	04 07 51.1	56.89	124.74	UURS	200.55	8.9	0.019	0.019	0.009	0.107	0.153	0.027
1986 7 6	02 13 38.3	56.66	125.24	CLNS	28.80	7.4	0.020	0.016	0.036	0.367	0.162	0.146
1986 7 8	03 51 59.6	56.88	125.83	USZ	261.11	9.4	0.056	0.135	0.105	0.245	0.202	0.192
1986 7 8	03 51 59.6	56.88	125.83	CLNS	56.73	10.0	0.408	0.235	0.585	2.693	1.008	1.224
1986 711	05 45 28.5	56.86	125.19	USZ	222.19	7.2	0.005	0.006	0.005	0.010	0.011	0.010
1986 713	07 16 27.2	55.09	124.68	USZ	253.00	7.0	0.005	0.004	0.007	0.010	0.009	0.009
1986 715	04 32 05.9	56.80	125.10	USZ	216.01	8.6	0.010	0.045	0.029	0.051	0.079	0.077
1986 715	04 32 05.9	56.80	125.10	CLNS	12.95	5.8	0.031	0.101	0.067	0.184	0.158	0.231
1986 715	04 32 05.9	56.80	125.10	TUG	225.26	8.8	0.011	0.022	0.023	0.085	0.088	0.105
1986 715	04 32 05.9	56.80	125.10	UURS	203.79	9.4	0.029	0.010	0.009	0.137	0.269	0.036
1986 715	04 32 05.9	56.80	125.10	KROS	289.14	8.8	0.006	0.005	0.010	0.007	0.010	0.015
1986 8 1	05 47 45.1	56.75	124.89	USZ	202.77	8.5	0.020	0.034	0.029	0.051	0.068	0.048
1986 8 1	05 47 45.1	56.75	124.89	TUG	214.48	8.9	0.021	0.005	0.035	0.085	0.131	0.047
1986 8 7	03 48 58.0	56.75	124.56	USZ	182.72	9.8	0.082	0.225	0.193	0.410	0.270	0.308
1986 8 7	03 48 58.0	56.75	124.56	TUG	195.31	9.6	0.149	0.219	0.117	0.213	0.307	0.164
1986 8 7	03 48 58.0	56.75	124.56	CGD	422.60	10.3	0.059	0.039	0.007	0.355	0.131	0.072
1986 811	05 50 06.6	56.85	125.00	USZ	210.59	8.7	0.030	0.039	0.024	0.081	0.084	0.087
1986 811	05 50 06.6	56.85	125.00	CLNS	6.08	6.1	0.163	0.235	0.255	1.530	0.956	0.703
1986 811	05 50 06.6	56.85	125.00	CGD	394.21	9.2	0.011	---	0.013	0.106	0.028	0.026
1986 814	04 55 10.0	59.84	125.07	TUG	353.67	8.5	0.006	0.030	0.005	0.032	0.043	0.023
1986 814	04 55 10.0	59.84	125.07	CGD	337.49	9.6	0.071	0.045	0.007	0.260	0.117	0.050
1986 912	03 48 36.5	56.76	124.69	CLNS	15.61	8.5	---	---	1.100	2.880	1.620	---
1986 912	03 48 36.5	56.76	124.69	USZ	190.72	9.5	---	---	0.170	0.260	0.220	---

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 912	03 48 36.5	56.76	124.69	TUG	202.51	9.5	---	---	0.140	0.170	0.290	---
1986 924	00 56 15.3	56.61	125.10	CLNS	28.34	7.2	---	---	0.036	0.140	0.178	0.365
1987 3 4	06 48 08.0	56.54	124.89	CLNS	33.38	8.9	---	---	0.932	2.163	0.883	---
1987 3 4	06 48 08.0	56.54	124.89	CGD	420.12	10.0	---	---	0.022	0.355	0.117	---
1987 420	06 22 02.3	56.77	124.75	TUG	205.66	9.5	0.043	0.066	0.082	0.149	0.219	0.164
1987 420	06 22 02.3	56.77	124.75	UURS	189.26	9.7	0.069	0.038	0.109	0.245	0.422	0.345
1987 5 6	07 43 34.4	57.09	125.34	CLNS	38.53	7.0	0.051	0.054	0.119	0.126	0.120	0.128
1987 5 6	07 43 34.4	57.09	125.34	TUG	233.58	8.0	0.013	0.013	0.009	0.050	0.048	0.036
1987 5 6	07 43 34.4	57.09	125.34	USZ	235.61	7.8	0.009	0.014	0.012	0.037	0.022	0.031
1987 515	02 40 06.6	57.23	125.22	CLNS	47.53	7.2	---	0.023	0.037	0.079	0.090	0.192
1987 515	03 30 10.8	56.92	124.75	UURS	203.78	10.5	0.098	0.115	0.145	0.176	1.190	0.254
1987 515	04 57 05.4	58.90	125.77	CLNS	234.87	9.0	0.016	0.023	0.027	0.079	0.113	0.164
1987 525	07 12 15.9	55.04	124.73	TUG	319.46	7.0	0.008	---	0.004	0.008	0.011	0.004
1987 527	02 42 07.0	55.11	126.98	UURS	239.81	8.1	---	0.021	0.027	0.024	0.019	0.027
1987 527	02 42 07.0	55.11	126.98	CLNS	231.94	8.3	0.011	0.015	0.037	0.009	0.039	0.037
1987 529	03 34 26.0	56.59	124.85	USZ	199.67	9.9	0.041	0.158	0.058	0.184	0.564	0.250
1987 529	03 34 26.0	56.59	124.85	TUG	218.08	9.1	0.030	0.052	0.057	0.070	0.151	0.134
1987 6 3	05 42 38.7	58.97	125.57	CGD	291.30	9.8	0.120	0.065	0.032	0.400	0.130	0.061
1987 6 3	05 42 38.7	58.97	125.57	CLNS	240.24	8.5	0.016	0.014	0.007	0.063	0.072	0.011
1987 6 4	07 45 25.2	58.71	125.61	CGD	289.08	9.2	0.028	0.044	0.012	0.180	0.125	0.058
1987 6 4	07 45 25.2	58.71	125.61	TUG	291.43	8.6	---	0.022	0.009	0.034	0.061	0.025
1987 6 5	04 59 47.9	56.91	124.66	TUG	196.33	9.0	0.026	0.052	0.084	0.110	0.110	0.130
1987 6 5	04 59 47.9	56.91	124.66	USZ	191.20	9.2	0.027	---	0.040	0.270	0.170	0.210
1987 6 5	04 59 47.9	56.91	124.66	UURS	200.24	9.6	0.030	0.020	0.051	0.250	0.330	0.170
1987 6 5	04 59 47.9	56.91	124.66	KROS	312.17	9.1	0.018	0.011	0.024	0.040	0.100	0.060
1987 6 7	08 00 30.1	57.19	125.07	USZ	222.70	7.5	0.003	0.007	0.006	0.015	0.007	0.006

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1987 6 7	08 00 30.1	57.19	125.07	CLNS	40.27	6.5	---	---	0.009	0.016	0.128	0.009
1987 6 7	08 00 30.1	57.19	125.07	TUG	216.34	7.8	0.008	0.010	0.017	0.026	0.006	0.022
1987 6 7	08 00 30.1	57.19	125.07	UURS	239.43	7.5	0.008	0.006	0.007	0.004	0.019	0.007
1987 6 8	05 46 23.8	56.41	124.79	USZ	197.16	9.4	0.015	0.022	0.029	0.287	0.101	0.154
1987 6 8	05 46 23.8	56.41	124.79	TUG	222.96	8.7	0.008	0.011	0.022	0.054	0.109	0.214
1987 6 8	05 46 23.8	56.41	124.79	UURS	157.80	9.2	0.039	0.019	0.027	0.186	0.135	0.108
1987 610	08 27 26.6	57.09	125.09	USZ	220.91	7.7	0.004	0.033	0.017	0.020	0.011	0.019
1987 610	08 27 26.6	57.09	125.09	TUG	218.57	7.8	0.011	0.043	0.013	0.017	0.032	0.017
1987 610	08 27 26.6	57.09	125.09	UURS	230.42	7.7	0.015	0.007	0.014	0.015	0.023	0.021
1987 616	02 55 43.9	59.28	126.55	CGD	240.21	9.0	0.055	0.023	0.017	0.240	0.150	0.040
1987 717	03 27 42.3	56.79	125.29	USZ	227.44	9.0	0.029	0.040	0.082	0.127	0.150	0.238
1987 717	03 27 42.3	56.79	125.29	CLNS	24.40	8.5	0.127	0.150	0.238	2.058	1.052	1.829
1987 717	03 27 42.3	56.79	125.29	TUG	236.73	9.4	0.064	0.043	0.045	0.129	0.130	0.112
1987 717	03 27 42.3	56.79	125.29	UURS	209.92	9.4	0.047	0.018	0.058	0.094	0.220	0.117
1987 9 2	06 23 26.9	58.91	125.65	CGD	286.47	8.6	0.059	0.026	0.011	0.166	0.078	0.020
1987 916	03 17 08.3	57.36	125.43	UURS	266.72	8.7	0.005	0.005	0.013	0.019	0.037	0.026
19871016	04 54 33.7	58.99	125.47	CGD	297.13	8.5	0.017	0.015	0.007	0.047	0.061	0.027
19871224	06 04 10.7	56.36	121.31	USZ	28.30	6.2	0.015	0.020	0.018	0.050	0.084	0.099
1988 326	08 43 20.2	57.33	124.90	USZ	218.19	7.7	0.010	0.010	0.010	0.020	0.020	0.020
1988 326	08 43 20.2	57.33	124.90	TUG	205.63	7.5	---	0.019	0.012	0.014	0.014	---
1988 516	01 13 16.3	57.00	125.07	USZ	217.52	6.5	0.007	---	0.005	0.007	0.009	0.005
1988 823	05 15 34.9	53.59	124.66	UURS	211.90	7.7	0.006	---	0.006	0.027	0.026	---
1990 823	06 10 29.7	57.22	124.88	USZ	212.82	7.2	0.004	0.004	0.004	0.014	0.010	0.013
1990 823	06 10 29.7	57.22	124.88	UURS	237.03	7.3	0.004	0.005	0.006	0.013	0.013	0.019
1990 823	10 32 26.6	58.73	125.88	TUG	305.96	9.1	0.020	0.035	0.032	0.195	0.120	0.110
1990 823	10 32 26.6	58.73	125.88	USZ	351.16	8.1	0.006	0.008	0.008	0.019	0.030	0.041

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
19901023	10 10 47.3	56.03	125.03	UURS	139.79	7.1	0.003	0.005	0.006	0.013	0.015	0.028
199011 5	09 49 49.3	56.02	125.50	UURS	164.16	7.5	0.017	0.018	0.019	0.025	0.026	0.028
19901130	09 38 05.4	56.11	125.63	UURS	176.06	7.0	0.005	0.003	0.004	0.025	0.014	0.008
19901212	03 23 30.9	56.12	125.73	UURS	182.01	7.6	0.012	0.010	0.018	0.031	0.025	0.025
1991 110	05 54 44.3	56.14	125.15	UURS	152.99	6.6	---	---	0.004	0.008	0.010	---
1991 221	08 50 39.0	56.48	124.87	UURS	166.93	6.6	0.008	0.003	0.003	0.009	0.011	0.014
1991 522	04 46 26.1	56.23	125.48	UURS	175.40	6.9	0.008	0.006	0.007	0.013	0.012	0.013
1991 524	01 02 01.6	56.36	125.59	UURS	189.45	6.8	0.005	0.004	0.003	0.008	0.009	0.011
1991 613	06 02 18.4	57.11	122.20	USZ	71.40	6.6	0.009	0.008	0.010	0.030	0.012	0.026
1993 222	08 31 10.1	56.23	125.33	USZ	233.07	7.0	0.005	0.005	0.005	0.018	0.019	0.010
1995 1 2	01 01 47.8	56.68	124.63	CLNS	24.21	4.8	0.003	0.003	0.003	0.015	0.006	0.009
1995 118	05 04 16.3	59.54	125.00	CGD	332.19	6.9	0.013	0.002	0.002	0.027	0.026	0.017
1995 120	05 28 25.2	58.00	125.24	CGD	324.46	6.9	0.013	0.013	0.010	0.054	0.026	0.027
1995 120	05 28 25.2	58.00	125.24	CGD	324.46	8.0	0.002	0.013	0.005	0.027	0.019	0.027
1995 4 4	06 58 60.2	55.14	125.16	UURS	124.60	5.8	0.004	0.007	0.004	0.095	0.096	0.147
1995 411	07 07 32.3	57.40	125.25	USZ	240.57	6.6	0.001	0.003	0.001	0.033	0.018	0.030
1995 422	02 57 57.8	59.00	125.60	CLNS	243.83	8.2	0.015	---	0.015	0.006	0.051	0.024
1995 628	03 21 15.8	58.87	125.84	CGD	275.47	7.1	0.009	0.009	0.005	0.038	0.028	0.028
1995 728	05 48 37.0	53.57	124.63	UURS	213.08	7.2	0.004	0.002	0.007	0.021	0.018	0.015
1996 111	06 30 6.7	58.94	125.52	CGD	294.03	8.4	0.005	0.029	0.014	0.051	0.074	0.027
1996 2 6	06 48 08.7	59.04	125.45	CGD	298.61	8.3	0.005	0.013	0.008	0.073	0.053	0.027
1996 3 7	04 50 39.6	58.99	125.73	CGD	282.25	8.4	0.005	0.013	0.004	0.054	0.053	0.049
1996 316	04 28 10.1	58.86	125.61	CGD	288.69	8.6	0.008	0.026	0.017	0.108	0.060	0.057
1996 411	05 20 30.8	58.78	125.63	CGD	287.62	8.7	0.008	0.026	0.017	0.125	0.048	0.067
1996 418	06 39 07.9	59.00	125.73	CLNS	245.25	8.1	0.015	0.012	0.015	0.033	0.045	0.018
1996 418	06 39 07.9	59.00	125.73	CGD	282.32	8.3	0.009	0.024	0.019	0.048	0.034	0.048

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1996 430	03 51 42.0	58.70	126.00	KROS	479.02	8.7	---	---	0.003	0.004	0.009	0.005
199612 3	04 17 22.6	56.76	124.77	USZ	195.57	7.7	0.011	0.014	0.028	0.029	0.013	0.024
199612 3	04 17 22.6	56.76	124.77	UURS	188.95	7.4	0.012	---	0.021	0.014	0.026	0.014
199612 4	05 38 57.4	58.85	125.81	CGD	277.18	7.8	---	---	0.009	0.034	0.029	0.029
1997 1 4	06 49 49.6	57.01	125.00	CLNS	19.88	6.2	0.015	0.015	0.015	0.241	0.181	0.105
1997 1 4	06 49 49.6	57.01	125.00	USZ	213.59	7.5	0.004	0.011	0.011	0.029	0.029	0.028
1997 218	05 51 11.4	53.43	124.76	UURS	230.82	7.6	0.005	0.005	0.009	0.024	0.024	0.026
1997 3 5	02 18 38.0	53.61	124.84	USZ	387.93	6.9	0.005	0.005	0.009	0.005	0.005	0.005
1997 3 5	02 18 38.0	53.61	124.84	CLNS	359.36	7.3	0.005	0.005	0.009	0.007	0.015	0.007
1997 327	02 58 22.1	58.65	125.31	KROS	480.71	8.0	0.006	---	0.007	0.011	0.009	---
1997 327	02 58 22.1	58.65	125.31	USZ	321.03	7.4	0.005	0.005	0.005	0.011	0.012	0.014
1997 327	02 58 22.1	58.65	125.31	CGD	306.83	8.8	0.034	0.025	0.059	0.257	0.082	0.092
1997 4 2	02 21 2.4	53.68	124.77	UURS	206.28	8.1	0.012	0.018	0.018	0.036	0.030	0.059
1997 4 2	04 09 56.1	53.68	125.42	UURS	229.66	7.7	0.006	0.008	0.003	0.024	0.036	0.024
1997 416	04 32 21.7	53.77	124.78	UURS	197.86	7.5	0.006	---	0.006	0.024	0.024	0.024
2000 517	08 43 26.3	56.92	124.92	KROS	305.90	8.8	0.011	0.005	0.011	0.021	0.041	0.025
2000 517	08 43 26.3	56.92	124.92	USZ	206.94	8.6	0.029	0.069	0.057	0.030	0.058	0.068
2000 519	04 15 46.9	58.79	125.81	USZ	352.65	7.4	0.001	0.002	0.001	0.018	0.011	0.010
2000 519	04 15 46.9	58.79	125.81	CGD	277.23	8.7	0.033	0.035	0.020	0.115	0.073	0.055

Earthquakes in the Magadan and Northern Yakutia Region

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1985 124	20 26 34.0	66.92	132.96	MOMR	453.74	11.1	0.042	0.050	0.077	0.357	0.840	0.480
1985 124	20 26 34.0	66.92	132.96	KHG	490.62	11.5	0.245	0.083	0.213	1.024	0.735	0.375
1985 124	20 26 34.0	66.92	132.96	UN1S	536.51	10.9	0.053	0.059	0.082	0.495	0.281	0.257
1985 124	20 26 34.0	66.92	132.96	YAK	567.72	11.6	0.243	0.087	0.265	0.596	1.020	0.287
1986 615	11 02 48.4	63.17	145.05	SUU	162.51	8.2	---	---	0.010	0.100	0.060	0.050
1986 615	11 02 48.4	63.17	145.05	UN1S	179.10	8.9	0.080	0.040	0.090	0.150	0.070	0.130
1986 615	11 02 48.4	63.17	145.05	SEY	370.38	8.3	0.006	0.011	0.011	0.028	0.017	0.022
1986 727	11 25 40.8	64.60	147.10	UN1S	184.91	10.6	0.390	0.700	0.520	0.790	1.100	0.580
1986 727	11 25 40.8	64.60	147.10	SUU	208.91	10.2	0.130	---	0.130	0.340	0.670	0.690
1986 727	11 25 40.8	64.60	147.10	MOMR	274.02	10.0	0.055	0.048	0.102	0.483	0.449	0.447
1986 727	11 25 40.8	64.60	147.10	DBI	310.03	10.3	0.070	0.050	0.100	0.410	0.430	0.400
1986 727	11 25 40.8	64.60	147.10	SEY	318.96	10.8	0.044	0.067	0.089	0.756	0.522	0.689
1986 727	11 25 40.8	64.60	147.10	KHG	609.27	11.2	0.026	0.035	0.031	0.613	0.335	0.357
1986 727	12 55 5.8	64.53	147.18	UN1S	188.97	8.3	0.010	0.024	0.022	0.092	0.024	0.085
1986 727	12 55 5.8	64.53	147.18	SEY	311.54	8.0	0.006	0.006	0.006	0.022	0.022	0.017
1986 810	11 11 59.5	63.55	147.80	SUU	87.38	9.4	0.060	0.030	0.060	0.330	0.600	0.300
1986 810	11 11 59.5	63.55	147.80	DBI	201.08	10.2	---	0.100	0.160	0.700	0.300	0.170
1986 810	11 11 59.5	63.55	147.80	SEY	239.46	8.1	0.022	0.056	0.056	0.444	0.233	0.372
1986 810	11 11 59.5	63.55	147.80	UN1S	249.50	9.6	0.039	0.050	0.025	0.294	0.121	0.326
1986 810	11 11 59.5	63.55	147.80	MGD	419.00	10.4	---	---	0.030	0.390	0.230	0.100
19861029	14 40 16.3	63.82	149.77	SEY	163.32	8.1	0.011	0.011	0.011	0.057	0.046	0.023
19861111	17 58 6.8	63.78	145.72	UN1S	149.10	9.4	0.090	0.120	0.060	0.300	0.300	0.100
19861111	17 58 6.8	63.78	145.72	SUU	164.68	9.7	0.170	0.090	0.150	0.320	0.540	0.360
19861111	17 58 6.8	63.78	145.72	SEY	345.25	9.2	0.011	0.011	0.011	0.103	0.046	0.057

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1987 119	17 28 15.7	64.06	148.18	SUU	142.35	7.6	0.009	0.009	0.009	0.027	0.036	0.018
1987 119	17 28 15.7	64.06	148.18	DBI	230.80	7.9	0.010	0.010	0.010	0.021	0.031	0.021
1987 119	17 28 15.7	64.06	148.18	SEY	243.29	8.0	0.006	0.011	0.011	0.028	0.022	0.022
1987 119	17 28 15.7	64.06	148.18	UN1S	245.28	7.6	0.010	0.010	0.010	0.020	0.030	0.010
1987 6 3	16 34 13.5	63.65	149.81	SEY	151.28	8.1	0.005	0.010	0.010	0.070	0.040	0.050
1987 6 3	16 34 13.5	63.65	149.81	DBI	153.39	7.8	0.007	0.007	0.015	0.030	0.037	0.030
1987 6 3	16 34 13.5	63.65	149.81	DBI	153.39	7.6	---	---	0.020	0.030	0.030	---
1987 6 3	16 34 13.5	63.65	149.81	SNE	177.64	7.6	---	---	0.007	0.020	0.027	0.020
1987 6 3	16 34 13.5	63.65	149.81	NKB	262.51	7.5	0.005	0.005	0.005	0.010	0.014	0.010
1987 728	17 17 32.1	61.82	145.56	SEY	372.82	7.8	---	0.005	0.005	0.015	0.010	0.020
1987 815	17 43 17.6	62.93	145.05	UN1S	202.86	7.7	0.018	0.028	0.026	0.043	0.055	0.045
1987 815	17 43 17.6	62.93	145.05	SEY	370.96	7.8	0.005	0.005	0.005	0.015	0.010	0.010
1987 822	17 22 34.0	63.42	149.71	DBI	131.34	7.5	0.007	0.007	0.007	0.030	0.030	0.022
1987 822	17 22 34.0	63.42	149.71	SEY	144.62	7.7	0.005	0.005	0.005	0.040	0.040	0.030
1987 925	15 30 9.8	64.34	147.74	SUU	174.67	7.8	0.040	---	0.010	0.030	0.050	0.020
1987 925	15 30 9.8	64.34	147.74	UN1S	217.89	7.8	0.005	0.015	0.010	0.027	0.013	0.030
1987 925	15 30 9.8	64.34	147.74	DBI	268.54	8.1	0.007	0.007	0.007	0.030	0.030	0.030
1987 925	15 30 9.8	64.34	147.74	SEY	277.51	7.8	0.005	0.005	0.005	0.020	0.020	0.020
1987 925	15 30 9.8	64.34	147.74	SNE	286.82	7.8	0.012	0.023	0.012	0.023	0.046	0.023
1987 925	15 30 9.8	64.34	147.74	NKB	338.54	8.2	0.008	0.007	0.007	0.015	0.030	0.022
1987 930	19 04 28.4	62.38	145.19	SUU	157.99	8.2	---	---	0.030	0.100	0.080	0.080
1987 930	19 04 28.4	62.38	145.19	NKB	222.51	9.5	0.015	0.030	0.015	0.218	0.194	0.127
1987 930	19 04 28.4	62.38	145.19	SNE	278.21	8.9	0.012	0.012	0.012	0.070	0.081	0.046
1987 930	19 04 28.4	62.38	145.19	DBI	286.96	8.3	0.007	0.015	0.015	0.030	0.030	0.037
1987 930	19 04 28.4	62.38	145.19	MOMR	464.36	9.1	0.055	---	0.086	0.180	0.019	0.015
198711 4	18 21 22.3	62.46	146.03	SUU	114.10	7.7	0.006	0.006	0.006	0.035	0.034	0.034

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
198711 4	18 21 22.3	62.46	146.03	SNE	236.16	7.8	---	---	0.012	0.023	0.023	0.023
19871129	20 28 3.5	63.99	149.03	SUU	141.54	8.2	0.009	0.009	0.008	0.036	0.089	0.062
19871129	20 28 3.5	63.99	149.03	SSY	160.03	8.2	0.036	0.025	0.038	0.097	0.090	0.090
19871129	20 28 3.5	63.99	149.03	ZYR	194.94	8.4	0.018	0.022	0.027	0.042	0.074	0.044
19871129	20 28 3.5	63.99	149.03	DBI	202.98	8.0	0.007	0.007	0.007	0.030	0.030	0.030
198712 7	10 50 58.6	63.68	145.56	UN1S	150.11	10.2	0.340	0.370	0.480	0.870	1.110	1.380
198712 7	10 50 58.6	63.68	145.56	SUU	163.80	10.9	0.480	0.375	0.405	1.815	1.000	0.792
198712 7	10 50 58.6	63.68	145.56	DBI	301.45	10.6	0.067	0.082	0.105	0.702	0.530	0.456
198712 7	10 50 58.6	63.68	145.56	SNE	307.67	10.5	0.093	0.116	0.093	0.278	0.719	0.418
198712 7	10 50 58.6	63.68	145.56	MOMR	328.85	10.6	0.045	0.050	0.090	0.350	0.360	0.170
198712 7	10 50 58.6	63.68	145.56	ZYR	301.06	10.9	0.064	0.180	0.150	0.830	0.640	0.500
198712 7	10 50 58.6	63.68	145.56	NZD	352.64	11.1	0.210	0.260	0.260	0.310	0.340	0.430
198712 7	10 50 58.6	63.68	145.56	OMS	529.61	10.0	---	---	0.020	0.150	0.120	---
19871220	18 26 10.5	62.22	146.05	SUU	124.54	9.1	0.036	0.098	0.097	0.205	0.161	0.106
19871220	18 26 10.5	62.22	146.05	SNE	232.84	9.8	0.023	0.035	0.035	0.302	0.232	0.371
19871220	18 26 10.5	62.22	146.05	DBI	243.58	9.3	0.007	0.022	0.030	0.149	0.097	0.082
19871220	18 26 10.5	62.22	146.05	UN1S	296.38	8.5	0.013	0.011	0.027	0.056	0.054	0.062
19871226	12 23 55.2	62.21	146.03	SUU	126.00	8.4	0.018	0.027	0.026	0.071	0.089	0.044
19871226	12 23 55.2	62.21	146.03	NKB	175.53	8.1	0.015	0.019	0.015	0.039	0.048	0.039
19871226	12 23 55.2	62.21	146.03	SNE	233.85	8.9	0.012	0.023	0.023	0.081	0.093	0.104
1988 119	10 35 32.1	63.71	145.68	UN1S	152.38	9.5	0.080	0.090	0.010	0.600	0.380	0.650
1988 119	10 35 32.1	63.71	145.68	SUU	161.17	10.4	0.205	0.107	0.176	0.943	0.911	0.757
1988 119	10 35 32.1	63.71	145.68	DBI	297.79	10.0	0.030	0.050	0.060	0.430	0.130	---
1988 119	10 35 32.1	63.71	145.68	SEY	345.54	10.0	0.020	0.030	0.035	0.220	0.170	0.220
1988 119	10 35 32.1	63.71	145.68	ZYR	294.74	9.6	0.051	0.050	0.053	0.670	0.250	0.080
1988 119	10 35 32.1	63.71	145.68	MYA	415.82	10.8	0.017	0.025	0.025	0.215	0.263	0.215

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1988 119	10 35 32.1	63.71	145.68	MGD	485.72	10.6	---	---	0.020	0.270	0.190	---
1988 122	12 51 56.5	62.20	146.03	DBI	244.83	9.1	---	0.050	0.050	0.210	0.070	---
1988 122	12 51 56.5	62.20	146.03	SEY	335.47	8.6	0.005	0.020	0.015	0.050	0.025	0.035
1988 122	12 51 56.5	62.20	146.03	UN1S	297.90	8.9	0.020	0.010	0.036	0.100	0.084	0.168
1988 122	12 51 56.5	62.20	146.03	MGD	347.92	9.5	---	---	0.002	0.190	0.080	---
1988 122	12 51 56.5	62.20	146.03	MYA	329.92	9.8	0.008	0.008	0.017	0.198	0.164	0.149
1988 328	13 21 18.3	63.92	149.41	SUU	141.51	8.3	0.018	0.018	0.018	0.071	0.080	0.044
1988 328	13 21 18.3	63.92	149.41	SEY	184.14	8.3	0.010	0.010	0.015	0.060	0.050	0.050
1988 6 2	14 56 28.5	62.38	145.19	SUU	157.99	9.5	0.053	0.098	0.106	0.231	0.223	0.255
1988 6 2	14 56 28.5	62.38	145.19	UN1S	261.96	8.9	0.052	0.022	0.050	0.104	0.102	0.126
1988 6 2	14 56 28.5	62.38	145.19	SEY	372.40	9.2	0.015	0.023	0.023	0.076	0.038	0.038
1988 6 2	14 56 28.5	62.38	145.19	MYA	376.79	10.0	0.017	0.016	0.017	0.182	0.214	0.132
1988 6 2	14 56 28.5	62.38	145.19	MYA	376.79	9.5	---	---	0.020	0.170	0.190	0.120
1988 614	14 44 44.2	63.37	149.50	SUU	94.52	9.8	0.098	0.143	0.106	0.614	0.661	0.387
1988 614	14 44 44.2	63.37	149.50	SEY	152.70	10.2	0.080	---	0.200	1.400	0.700	0.800
1988 614	14 44 44.2	63.37	149.50	NKB	229.07	9.0	0.048	---	0.049	0.116	0.105	0.184
1988 614	14 44 44.2	63.37	149.50	MYA	255.36	10.0	0.079	0.073	0.118	0.330	0.352	0.339
1988 614	14 44 44.2	63.37	149.50	SSY	230.84	9.3	0.069	0.080	0.067	0.140	0.220	0.160
1988 614	14 44 44.2	63.37	149.50	UN1S	333.71	9.7	0.050	0.040	0.040	0.190	0.140	0.090
1988 614	14 44 44.2	63.37	149.50	MGD	375.38	10.3	---	---	0.070	0.360	0.200	---
1988 614	14 44 44.2	63.37	149.50	UL2S	319.12	9.3	0.046	0.065	0.026	0.250	0.230	0.080
1988 615	15 24 19.4	64.56	145.36	SSY	104.89	7.7	0.023	---	0.025	0.065	0.080	0.032
1988 615	15 24 19.4	64.56	145.36	UN1S	101.88	8.4	0.013	0.025	0.036	0.155	0.140	0.130
1988 615	15 24 19.4	64.56	145.36	SEY	389.77	8.6	0.005	0.010	0.010	0.030	0.030	0.020
19881025	10 12 52.8	62.87	148.85	SUU	36.99	8.7	0.192	0.209	0.245	0.587	0.874	0.748
19881025	10 12 52.8	62.87	148.85	SEY	179.08	10.6	0.103	0.265	0.235	1.471	0.647	0.647

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
19881025	10 12 52.8	62.87	148.85	UN1S	334.92	9.6	0.050	0.060	0.040	0.150	0.110	0.210
198811 2	14 49 55.1	62.25	145.04	ATKR	214.82	8.3	---	0.016	0.032	0.061	0.065	0.046
198811 2	14 49 55.1	62.25	145.04	NKB	222.65	8.9	0.010	0.019	0.010	0.116	0.116	0.049
198811 2	14 49 55.1	62.25	145.04	UN1S	272.96	8.0	0.011	---	0.016	0.022	0.034	0.033
198811 2	14 49 55.1	62.25	145.04	SSY	338.69	8.0	0.004	---	0.013	0.018	0.039	0.043
198811 2	14 49 55.1	62.25	145.04	SEY	383.36	8.5	0.008	0.008	0.008	0.030	0.030	0.030
1989 321	10 53 5.2	64.91	145.19	SUU	277.74	9.8	---	---	0.110	0.190	0.200	0.230
1989 321	10 53 5.2	64.91	145.19	SEY	414.44	10.3	0.015	0.020	0.020	0.275	0.150	0.150
1989 321	10 53 5.2	64.91	145.19	NZD	403.89	10.5	0.057	0.040	0.038	0.121	0.142	0.153
1989 5 6	19 56 26.4	62.29	145.43	DBI	275.02	9.2	---	---	0.020	0.130	0.040	---
1989 5 6	19 56 26.4	62.29	145.43	UN1S	275.85	8.5	0.010	0.010	0.020	0.040	0.070	0.050
1989 5 6	19 56 26.4	62.29	145.43	SEY	362.70	8.3	0.005	0.010	0.005	0.030	0.020	0.035
1989 531	20 37 55.1	63.89	148.33	SUU	123.75	8.9	0.090	0.030	0.060	0.210	0.290	---
1989 531	20 37 55.1	63.89	148.33	DBI	211.17	9.1	0.030	0.030	0.060	0.150	0.160	---
1989 531	20 37 55.1	63.89	148.33	SEY	228.04	7.7	0.010	0.025	0.020	0.280	0.230	0.230
1989 531	20 37 55.1	63.89	148.33	UN1S	257.91	9.0	0.020	0.030	0.020	0.110	0.100	0.150
1989 531	20 37 55.1	63.89	148.33	NKB	285.17	9.1	0.060	---	0.030	0.090	0.130	0.030
1989 616	19 40 45.7	61.02	145.44	NKB	184.01	9.5	0.070	0.020	0.050	0.450	0.250	0.260
1989 616	19 40 45.7	61.02	145.44	SUU	241.85	9.6	0.030	0.040	0.030	0.190	0.280	0.100
1989 616	19 40 45.7	61.02	145.44	MGD	308.98	10.3	---	---	0.030	0.440	0.280	---
1989 616	19 40 45.7	61.02	145.44	DBI	316.26	9.7	---	---	0.030	0.130	0.190	0.130
1989 616	19 40 45.7	61.02	145.44	UN1S	410.14	9.7	0.020	0.020	0.030	0.050	0.060	0.070
1989 616	19 40 45.7	61.02	145.44	SEY	420.34	9.5	0.010	0.015	0.015	0.100	0.065	0.095
1989 714	14 00 51.4	63.69	145.46	UN1S	145.72	8.9	0.030	0.030	0.040	0.240	0.120	0.180
1989 714	14 00 51.4	63.69	145.46	SUU	168.45	9.1	0.060	---	0.090	0.210	0.150	---
1989 714	14 00 51.4	63.69	145.46	NKB	313.17	8.7	0.030	---	0.050	0.050	0.070	---

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1989 714	14 00 51.4	63.69	145.46	SEY	355.75	8.9	0.005	0.005	0.010	0.065	0.040	0.050
1989 714	14 00 51.4	63.69	145.46	SEY	355.75	8.1	0.008	0.015	0.015	0.061	0.038	0.030
198910 4	20 56 47.6	64.70	146.83	SSY	52.27	8.7	0.061	0.075	0.127	0.244	0.613	0.289
198910 4	20 56 47.6	64.70	146.83	ZYR	176.43	9.9	0.209	0.350	0.305	0.615	0.679	0.864
198910 4	20 56 47.6	64.70	146.83	SUU	223.18	10.7	0.310	0.230	0.390	1.080	0.870	---
198910 4	20 56 47.6	64.70	146.83	SEY	335.82	10.8	0.053	0.061	0.076	0.856	0.515	0.591
198910 4	20 56 47.6	64.70	146.83	NKB	387.27	10.7	0.260	0.180	0.130	0.390	0.500	---
198910 4	20 56 47.6	64.70	146.83	OMS	504.08	11.2	---	---	0.120	1.740	0.780	---
198910 4	20 56 47.6	64.70	146.83	MGD	555.18	10.6	---	---	0.080	0.370	0.500	---
1990 121	14 37 11.8	63.10	151.95	SEY	28.63	8.8	0.520	0.600	0.540	1.700	1.270	---
1990 121	14 37 11.8	63.10	151.95	DBI	104.43	8.9	0.080	---	0.050	0.370	0.270	---
1990 121	14 37 11.8	63.10	151.95	SUU	195.60	9.4	0.030	---	0.030	0.350	0.070	---
1990 121	14 37 11.8	63.10	151.95	OMS	204.98	8.7	0.020	0.030	0.030	0.100	0.120	---
1990 121	14 37 11.8	63.10	151.95	NKB	254.99	9.3	---	---	0.020	0.160	0.070	0.190
1990 121	14 37 11.8	63.10	151.95	KU-	268.33	8.8	---	---	0.030	0.060	0.040	---
1990 121	14 37 11.8	63.10	151.95	ATKR	357.32	8.7	---	---	0.010	0.051	0.048	---
1990 121	14 37 11.8	63.10	151.95	SSY	329.13	8.8	0.014	0.021	0.030	0.064	0.093	0.081
1990 3 5	12 41 40.7	60.62	141.41	NZD	243.15	7.5	0.007	0.004	0.006	0.022	0.025	0.018
1990 3 7	12 40 9.2	63.66	142.37	UN1S	109.04	7.4	0.004	0.004	0.003	0.034	0.038	0.042
1990 3 7	12 40 9.2	63.66	142.37	NZD	211.05	7.5	0.009	0.007	0.008	0.018	0.022	0.023
1990 318	11 00 30.2	64.90	148.54	SSY	74.57	6.1	0.006	0.003	0.004	0.012	0.011	0.013
1990 318	14 09 57.2	66.75	145.05	SSY	199.43	6.6	0.004	0.003	0.006	0.009	0.007	0.005
1990 318	20 55 6.4	67.87	140.91	TBK	188.77	7.8	0.009	0.003	0.014	0.067	0.034	0.056
1990 323	16 03 14.0	71.10	130.60	NAY	28.24	6.3	0.036	0.027	0.022	0.160	0.158	0.066
1990 329	20 47 29.8	64.02	145.04	UN1S	106.45	9.1	0.044	0.050	0.055	0.368	0.338	0.281
1990 329	20 47 29.8	64.02	145.04	ZYR	291.08	10.0	0.029	0.094	0.138	0.206	0.262	---

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1990 329	20 47 29.8	64.02	145.04	MOMR	285.11	9.2	---	---	0.020	0.120	0.120	---
1990 329	20 47 29.8	64.02	145.04	NKB	355.08	9.5	---	---	0.030	0.120	0.150	---
1990 329	20 47 29.8	64.02	145.04	NZD	343.84	9.6	0.035	0.068	0.080	0.191	0.146	---
1990 329	20 47 29.8	64.02	145.04	DBI	342.08	9.6	---	---	0.010	0.180	0.070	---
1990 329	20 47 29.8	64.02	145.04	MGD	532.04	10.2	---	---	0.020	0.150	0.170	0.040
1990 330	15 15 38.6	64.04	145.07	ATKR	15.90	7.4	0.556	0.258	0.427	1.724	2.235	2.563
1990 330	15 15 38.6	64.04	145.07	UN1S	106.39	8.7	0.013	0.025	0.025	0.220	0.200	0.245
1990 330	15 15 38.6	64.04	145.07	SSY	156.93	9.0	0.047	0.047	0.076	0.234	0.219	0.178
1990 330	15 15 38.6	64.04	145.07	SUU	207.65	8.6	0.040	0.030	0.040	0.130	0.070	0.150
1990 330	15 15 38.6	64.04	145.07	NZD	346.15	8.7	0.020	0.021	0.027	0.059	0.052	---
1990 4 1	17 09 18.0	64.03	144.98	ATKR	18.28	6.3	0.120	0.039	0.100	0.375	0.985	0.425
1990 4 1	17 09 18.0	64.03	144.98	UN1S	103.44	6.9	0.009	0.007	0.004	0.018	0.015	0.018
1990 4 1	17 09 18.0	64.03	144.98	SSY	160.47	7.7	0.019	0.008	0.014	0.052	0.053	0.030
1990 4 2	15 32 46.9	62.12	138.02	UN1S	376.08	9.9	0.017	0.022	0.017	0.261	0.323	0.248
1990 4 2	15 32 46.9	62.12	138.02	ATKR	424.26	10.5	0.014	0.031	0.034	0.604	0.275	0.253
1990 4 2	15 32 46.9	62.12	138.02	MOMR	544.30	10.8	0.020	0.013	0.017	0.126	0.143	0.101
1990 4 2	15 32 46.9	62.12	138.02	CGD	552.31	10.1	0.044	0.044	0.018	0.219	0.259	0.121
1990 4 2	15 32 46.9	62.12	138.02	SSY	559.80	10.4	0.012	0.019	0.015	0.284	0.183	0.254
1990 4 2	15 32 46.9	62.12	138.02	BTG	635.52	9.8	0.013	0.007	0.013	0.055	0.074	0.069
1990 4 2	15 32 46.9	62.12	138.02	DBI	659.29	10.5	0.030	0.040	0.050	0.130	0.030	0.040
1990 4 2	15 32 46.9	62.12	138.02	OMS	915.75	10.3	0.010	0.020	0.020	0.040	0.050	0.010
1990 412	19 10 48.4	62.40	138.12	KHG	134.44	9.6	0.011	0.006	0.028	0.089	0.054	0.055
1990 412	19 10 48.4	62.40	138.12	UN1S	349.69	8.9	0.007	0.028	0.020	0.099	0.085	0.088
1990 412	19 10 48.4	62.40	138.12	ATKR	402.46	9.2	0.007	0.008	0.014	0.137	0.070	0.073
1990 412	19 10 48.4	62.40	138.12	CGD	576.45	9.3	0.010	0.010	0.006	0.072	0.044	0.034
1990 423	14 15 13.7	67.52	132.27	SAY	159.38	8.9	0.019	0.025	0.059	0.282	0.209	0.208

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1990 423	14 15 13.7	67.52	132.27	TBK	180.79	8.3	0.016	0.011	0.047	0.089	0.063	0.069
1990 425	17 32 37.8	66.04	134.00	BTG	181.19	7.6	0.013	0.004	0.014	0.018	0.038	0.034
1990 425	17 32 37.8	66.04	134.00	TBK	200.06	7.8	0.008	0.007	0.027	0.033	0.039	0.033
1990 5 5	16 22 0.0	62.92	139.80	KHG	217.91	7.8	0.004	0.004	0.010	0.061	0.047	0.023
1990 5 5	16 22 0.0	62.92	139.80	UN1S	248.90	7.6	0.004	0.005	0.005	0.003	0.022	0.027
1990 5 5	16 22 0.0	62.92	139.80	ATKR	299.06	7.6	0.004	0.004	0.006	0.022	0.014	0.024
1990 5 7	12 33 18.3	67.63	142.55	MOMR	132.62	8.5	0.036	0.019	0.040	0.186	0.188	0.222
1990 5 7	12 33 18.3	67.63	142.55	TLI	292.70	8.0	0.011	0.013	0.013	0.039	0.139	0.040
1990 5 7	12 33 18.3	67.63	142.55	SAY	355.35	8.5	0.013	0.016	0.017	0.064	0.073	0.042
1990 520	11 44 22.7	67.45	143.59	MOMR	110.60	7.4	0.007	0.004	0.005	0.240	0.040	0.020
1990 530	11 56 45.7	62.91	144.88	ATKR	141.90	10.0	0.560	0.085	0.283	0.666	0.895	0.651
1990 530	11 56 45.7	62.91	144.88	SUU	166.57	10.4	0.180	0.590	0.390	1.640	0.950	---
1990 530	11 56 45.7	62.91	144.88	UN1S	201.35	10.2	0.067	0.084	0.161	0.425	0.526	0.512
1990 530	11 56 45.7	62.91	144.88	NKB	269.01	10.0	0.130	0.130	0.060	0.350	0.350	0.180
1990 530	11 56 45.7	62.91	144.88	SSY	271.99	9.8	0.049	0.040	0.065	0.318	0.447	0.256
1990 530	11 56 45.7	62.91	144.88	DBI	306.86	10.0	---	---	0.030	0.340	0.230	---
1990 530	11 56 45.7	62.91	144.88	SEY	379.69	10.3	---	0.008	0.060	0.460	0.360	---
1990 530	11 56 45.7	62.91	144.88	TTY	599.37	10.1	---	---	0.020	0.080	0.150	---
1990 530	14 06 4.0	62.90	144.92	ATKR	142.86	8.9	0.040	0.140	0.048	0.178	0.368	0.141
1990 530	14 06 4.0	62.90	144.92	SUU	164.49	9.2	0.040	---	0.040	0.340	0.200	---
1990 530	14 06 4.0	62.90	144.92	UN1S	203.17	8.6	0.014	0.015	0.020	0.004	0.124	0.116
1990 530	14 06 4.0	62.90	144.92	SSY	272.26	8.5	0.012	0.018	0.008	0.062	0.074	0.052
1990 530	14 06 4.0	62.90	144.92	SEY	377.75	9.1	---	0.020	0.020	0.090	0.070	---
1990 6 1	13 32 50.8	67.77	131.97	SAY	145.48	7.2	0.007	0.005	0.009	0.013	0.019	0.010
1990 6 3	20 20 6.6	66.34	140.92	MOMR	103.25	7.4	0.007	0.009	0.009	0.031	0.039	0.034
1990 6 3	20 20 6.6	66.34	140.92	UN1S	224.32	7.5	0.004	0.004	0.005	0.048	0.029	0.029

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1990 6 3	20 20 6.6	66.34	140.92	TBK	233.40	7.9	0.008	0.011	0.016	0.039	0.034	0.043
1990 6 3	20 20 6.6	66.34	140.92	ATKR	310.02	7.5	0.008	0.004	0.006	0.014	0.017	0.014
1990 6 3	20 20 6.6	66.34	140.92	SSY	310.28	7.3	0.003	0.005	0.006	0.009	0.015	0.007
1990 6 6	13 57 49.6	65.41	135.11	TBK	244.98	10.1	0.054	0.054	0.125	0.416	0.459	0.447
1990 6 6	13 57 49.6	65.41	135.11	KHG	307.82	9.5	0.020	0.012	0.034	0.332	0.225	0.084
1990 6 6	13 57 49.6	65.41	135.11	SAY	367.12	10.1	0.021	0.015	0.016	0.127	0.244	0.109
1990 6 6	13 57 49.6	65.41	135.11	NZD	376.95	9.4	0.023	0.018	0.019	0.131	0.130	0.117
1990 6 6	13 57 49.6	65.41	135.11	UNIS	392.91	9.1	0.016	0.040	0.040	0.083	0.067	---
1990 6 6	13 57 49.6	65.41	135.11	MOMR	385.72	9.9	---	---	0.013	0.068	0.074	---
1990 612	20 44 51.0	63.90	144.90	UNIS	109.65	6.3	0.003	0.003	0.002	0.007	0.008	0.008
1990 625	13 12 48.2	66.88	130.45	BTG	198.84	8.2	0.016	0.018	0.024	0.068	0.061	0.057
1990 625	13 12 48.2	66.88	130.45	SAY	263.13	8.8	0.010	0.020	0.010	0.050	0.160	0.030
1990 625	13 12 48.2	66.88	130.45	TBK	271.63	8.8	0.010	0.010	0.020	0.070	0.060	0.050
1990 625	13 12 48.2	66.88	130.45	NAY	441.81	9.3	0.010	0.010	0.010	0.030	0.025	0.020
1991 210	18 16 32.0	62.94	145.58	SSY	257.28	11.2	0.594	0.859	0.869	1.878	1.582	1.604
1991 210	18 16 32.0	62.94	145.58	KU-	150.47	10.8	0.041	1.100	1.240	1.700	1.270	2.250
1991 210	18 16 32.0	62.94	145.58	NKB	244.91	10.7	0.380	0.520	0.270	1.120	0.230	0.480
1991 210	18 16 32.0	62.94	145.58	DBI	272.63	11.4	0.240	0.430	0.520	2.260	0.570	1.150
1991 210	18 16 32.0	62.94	145.58	NZD	336.03	11.3	0.310	0.670	0.352	1.637	1.335	1.271
1991 210	18 16 32.0	62.94	145.58	SEY	344.11	10.9	0.140	0.420	0.029	0.890	0.320	0.210
1991 210	18 16 32.0	62.94	145.58	MOMR	408.04	11.3	0.167	0.197	0.295	1.780	1.400	0.557
1991 210	18 16 32.0	62.94	145.58	TL-S	408.03	11.3	0.360	0.360	0.270	4.990	6.400	3.630
1991 210	18 16 32.0	62.94	145.58	MGD	422.11	11.9	0.300	0.350	0.630	0.860	3.480	0.390
1991 210	18 16 32.0	62.94	145.58	KHG	510.28	11.5	0.120	0.085	0.149	1.067	1.073	0.947
1991 210	18 16 32.0	62.94	145.58	OMS	521.26	11.2	0.080	0.120	0.140	0.590	0.180	0.470
1991 210	18 16 32.0	62.94	145.58	EVE	710.53	11.7	---	---	0.080	0.530	0.310	0.700

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 210	18 16 32.0	62.94	145.58	OMO	768.30	11.4	---	0.040	0.050	0.340	0.260	0.160
1991 210	18 16 32.0	62.94	145.58	TBK	661.92	12.8	0.114	0.108	0.196	0.730	0.842	1.118
1991 3 1	18 14 14.0	60.02	152.79	TTY	106.58	10.0	---	---	0.400	0.540	0.790	0.330
1991 3 1	18 14 14.0	60.02	152.79	MGD	114.51	10.0	0.210	0.220	0.490	1.120	1.170	0.520
1991 3 1	18 14 14.0	60.02	152.79	MAG	122.43	9.7	---	0.040	0.040	0.570	0.720	0.430
1991 3 1	18 14 14.0	60.02	152.79	TL-S	125.43	10.1	0.090	0.090	0.050	0.720	0.250	0.140
1991 3 1	18 14 14.0	60.02	152.79	DBI	280.17	9.2	0.020	0.020	0.030	0.110	0.140	0.070
1991 3 1	18 14 14.0	60.02	152.79	KU-	356.58	9.3	---	---	0.010	0.120	0.180	0.140
1991 3 1	18 14 14.0	60.02	152.79	SUU	394.01	9.2	---	---	0.020	0.070	0.070	---
1991 3 7	12 28 43.0	63.34	140.03	NZD	105.88	8.3	0.041	0.040	0.048	0.111	0.126	0.098
1991 3 7	12 28 43.0	63.34	140.03	UN1S	207.33	8.7	0.021	0.021	0.017	0.155	0.159	0.110
1991 3 7	12 28 43.0	63.34	140.03	KHG	238.58	8.5	0.007	0.008	0.005	0.105	0.085	0.062
1991 3 7	16 20 43.0	61.28	157.00	EVE	137.91	11.4	0.140	0.090	0.190	4.700	2.290	4.320
1991 3 7	16 20 43.0	61.28	157.00	TTY	174.15	11.0	0.070	0.310	0.360	2.840	0.610	0.820
1991 3 7	16 20 43.0	61.28	157.00	TL-S	247.59	11.0	0.120	0.230	0.160	1.720	1.350	1.240
1991 3 7	16 20 43.0	61.28	157.00	DBI	348.74	10.7	---	0.120	0.120	0.670	0.300	0.400
1991 3 7	16 20 43.0	61.28	157.00	MGD	368.11	10.9	---	---	0.080	0.860	0.630	0.400
1991 3 7	16 20 43.0	61.28	157.00	NKB	437.30	10.7	0.030	0.040	0.120	0.370	0.120	0.130
1991 3 7	16 20 43.0	61.28	157.00	OMO	473.73	11.3	---	---	0.090	0.960	0.330	---
1991 3 7	16 20 43.0	61.28	157.00	SUU	490.59	10.9	0.020	0.040	0.020	0.560	0.290	0.220
1991 310	19 01 25.5	64.40	140.04	UN1S	153.87	8.2	0.006	0.005	0.007	0.165	0.065	0.091
1991 310	19 01 25.5	64.40	140.04	NZD	217.23	7.8	0.005	0.004	0.005	0.066	0.070	0.056
1991 316	11 02 10.1	62.39	153.10	DBI	121.34	10.7	0.380	0.650	1.150	1.440	0.950	0.780
1991 316	11 02 10.1	62.39	153.10	OMS	138.28	10.4	0.010	0.320	0.350	1.140	0.280	0.740
1991 316	11 02 10.1	62.39	153.10	TL-S	145.06	10.7	0.080	0.180	0.290	2.140	1.640	2.000
1991 316	11 02 10.1	62.39	153.10	NKB	253.80	10.4	0.080	0.090	0.090	0.770	0.350	0.140

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 316	11 02 10.1	62.39	153.10	SUU	257.24	10.0	0.040	0.090	0.070	0.420	0.180	0.330
1991 316	11 02 10.1	62.39	153.10	TTY	257.61	10.9	0.130	0.100	0.190	1.630	1.280	0.130
1991 316	11 02 10.1	62.39	153.10	MGD	289.95	10.7	---	---	0.060	1.120	0.990	---
1991 316	11 02 10.1	62.39	153.10	KU-	299.96	9.9	0.020	---	0.110	0.310	0.300	0.310
1991 316	11 02 10.1	62.39	153.10	EVE	322.67	10.3	0.040	0.090	0.140	0.410	0.380	---
1991 317	17 42 3.9	64.24	146.19	ATKR	51.58	7.3	0.038	0.028	0.038	0.134	0.085	0.084
1991 317	17 42 3.9	64.24	146.19	SSY	110.48	7.9	0.021	0.016	0.016	0.084	0.146	0.087
1991 317	17 42 3.9	64.24	146.19	UN1S	146.90	8.1	0.008	0.013	0.009	0.091	0.050	0.079
1991 322	16 00 22.9	62.35	148.41	SUU	49.76	9.0	0.370	0.170	0.240	0.670	0.850	0.240
1991 322	16 00 22.9	62.35	148.41	NKB	114.70	9.7	0.190	0.280	0.180	0.720	0.670	0.180
1991 322	16 00 22.9	62.35	148.41	DBI	120.88	9.6	---	0.070	0.080	0.620	0.330	0.330
1991 322	16 00 22.9	62.35	148.41	SEY	213.13	9.5	---	0.080	0.060	0.290	0.100	---
1991 322	16 00 22.9	62.35	148.41	TL-S	249.63	10.0	0.040	0.040	0.030	0.180	0.520	---
1991 322	16 00 22.9	62.35	148.41	OMS	379.39	8.9	---	0.020	0.020	0.060	0.040	---
1991 513	12 58 48.4	62.92	145.54	SUU	133.33	8.6	---	0.040	0.050	0.300	0.110	0.270
1991 513	12 58 48.4	62.92	145.54	ATKR	141.69	8.5	0.071	0.025	0.105	0.167	0.142	0.067
1991 513	12 58 48.4	62.92	145.54	UN1S	215.55	8.6	0.016	0.014	0.018	0.136	0.136	0.117
1991 513	12 58 48.4	62.92	145.54	SSY	259.98	8.1	0.013	0.012	0.013	0.030	0.055	0.040
1991 522	15 48 6.8	67.24	139.58	BTG	216.24	9.1	0.041	0.049	0.027	0.155	0.236	0.143
1991 522	15 48 6.8	67.24	139.58	SAY	268.57	9.3	0.047	0.029	0.023	0.235	0.297	0.046
1991 522	15 48 6.8	67.24	139.58	UN1S	340.40	9.3	0.028	0.020	0.024	0.140	0.136	0.174
1991 522	15 48 6.8	67.24	139.58	TLI	331.02	8.3	0.008	0.009	0.008	0.024	0.046	0.038
1991 522	15 48 6.8	67.24	139.58	SSY	408.07	9.0	0.011	0.015	0.009	0.062	0.090	0.034
1991 524	12 59 7.2	64.00	149.17	SSY	163.13	8.4	0.022	0.013	0.026	0.079	0.159	0.105
1991 524	12 59 7.2	64.00	149.17	ATKR	197.22	7.8	0.004	0.005	0.011	0.028	0.045	0.045
1991 524	12 59 7.2	64.00	149.17	UN1S	293.57	7.8	0.003	0.003	0.004	0.029	0.014	0.029

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 624	20 04 19.2	65.03	145.84	SSY	59.59	7.2	0.022	0.022	0.055	0.113	0.069	0.097
1991 624	20 04 19.2	65.03	145.84	ATKR	100.34	7.8	0.003	0.004	0.004	0.043	0.081	0.059
1991 624	20 04 19.2	65.03	145.84	UN1S	134.07	8.2	0.006	0.018	0.015	0.118	0.075	---
1991 624	20 04 19.2	65.03	145.84	MOMR	199.75	8.1	0.015	0.014	0.025	0.064	0.058	0.033
1991 7 2	13 43 48.7	65.18	139.84	UN1S	173.98	8.5	0.080	---	0.100	0.258	0.117	0.177
1991 7 2	13 43 48.7	65.18	139.84	MOMR	210.08	8.9	0.036	0.055	0.055	0.190	0.228	0.139
1991 7 2	13 43 48.7	65.18	139.84	ATKR	275.19	8.5	0.019	---	0.037	0.096	0.082	0.068
1991 7 2	13 43 48.7	65.18	139.84	NZD	300.91	9.0	0.027	---	0.039	0.102	0.101	0.199
1991 7 2	13 43 48.7	65.18	139.84	TBK	301.19	9.6	0.038	0.036	0.044	0.216	0.380	0.469
1991 722	13 49 19.8	62.20	143.54	NZD	233.69	8.5	0.005	0.013	0.015	0.073	0.059	0.090
1991 722	13 49 19.8	62.20	143.54	ATKR	234.38	7.8	0.005	0.009	0.007	0.046	0.038	0.027
1991 722	13 49 19.8	62.20	143.54	UN1S	263.66	7.8	0.003	0.009	0.009	0.021	0.036	0.035
1991 8 4	19 08 6.2	65.47	143.22	ATKR	169.61	10.2	0.409	0.245	0.655	1.093	0.984	1.253
1991 8 4	19 08 6.2	65.47	143.22	SSY	182.41	10.5	0.169	0.312	0.519	1.457	1.800	1.975
1991 8 4	19 08 6.2	65.47	143.22	TBK	375.47	11.2	0.223	0.393	0.461	1.081	1.838	1.718
1991 8 4	19 08 6.2	65.47	143.22	NZD	387.92	11.0	0.307	0.176	0.226	0.420	1.222	0.767
1991 8 4	19 08 6.2	65.47	143.22	BTG	450.52	10.8	0.030	0.068	0.059	0.909	0.798	0.565
1991 8 4	19 08 6.2	65.47	143.22	SUU	382.90	10.9	0.022	0.100	0.020	0.866	0.260	---
1991 8 4	19 08 6.2	65.47	143.22	SEY	524.99	10.4	0.040	0.050	0.060	0.031	0.130	---
1991 8 4	19 08 6.2	65.47	143.22	OMS	693.39	10.3	---	---	0.020	0.110	0.090	---
1991 8 4	19 14 40.5	65.48	143.25	UN1S	101.71	9.5	0.363	0.202	0.302	0.716	0.716	0.516
1991 8 4	19 14 40.5	65.48	143.25	MOMR	109.78	9.0	0.169	0.071	0.184	0.220	0.506	0.202
1991 8 4	19 14 40.5	65.48	143.25	ATKR	169.80	9.5	0.101	0.149	0.204	0.586	0.395	0.463
1991 8 4	19 14 40.5	65.48	143.25	SSY	181.23	9.5	0.054	0.083	0.215	0.416	0.503	0.377
1991 8 4	19 14 40.5	65.48	143.25	SUU	382.84	9.6	0.060	---	0.060	0.150	0.060	0.130
1991 8 4	19 14 40.5	65.48	143.25	TBK	375.80	9.8	0.028	---	0.065	0.189	0.270	0.313

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1991 8 4	19 14 40.5	65.48	143.25	NZD	389.60	9.7	0.068	0.040	0.038	0.173	0.269	0.192
1991 8 4	19 14 40.5	65.48	143.25	NKB	537.27	10.1	0.030	---	0.020	0.160	0.060	0.050
1991 9 7	11 28 33.9	60.52	151.68	TL-S	78.00	8.3	0.050	0.050	0.050	0.150	0.130	0.040
1991 9 7	11 28 33.9	60.52	151.68	MGD	74.30	8.7	---	---	0.180	0.250	0.290	---
1991 9 7	11 28 33.9	60.52	151.68	NKB	179.83	8.7	---	---	0.020	0.180	0.110	0.080
1991 9 7	11 28 33.9	60.52	151.68	DBI	208.30	8.9	0.020	---	0.030	0.120	0.180	0.100
1991 9 7	20 53 39.8	59.96	153.16	TTY	88.42	9.9	0.090	0.240	0.470	1.140	1.100	---
1991 9 7	20 53 39.8	59.96	153.16	TL-S	136.83	9.2	0.060	0.060	0.110	0.230	0.260	0.160
1991 9 7	20 53 39.8	59.96	153.16	MGD	135.50	9.4	---	---	0.130	0.260	0.420	---
1991 9 7	20 53 39.8	59.96	153.16	DBI	294.52	8.7	---	---	0.020	0.070	0.060	0.060
199111 5	10 16 38.6	59.01	150.60	MGD	115.53	10.5	0.150	---	0.270	4.100	5.000	---
199111 5	10 16 38.6	59.01	150.60	NKB	277.10	9.5	0.100	0.030	0.050	0.160	0.090	0.080
199111 5	10 16 38.6	59.01	150.60	TTY	265.00	11.3	0.070	0.300	0.240	1.840	2.940	---
199111 5	10 16 38.6	59.01	150.60	SUU	439.86	9.4	0.040	---	0.020	0.100	0.050	---
199112 1	17 13 50.3	59.41	147.66	MGD	186.12	9.3	---	---	0.090	0.018	0.330	---
199112 1	17 13 50.3	59.41	147.66	NKB	223.38	9.1	0.040	0.020	0.030	0.150	0.210	0.080
1992 828	14 27 5.1	58.94	149.22	TL-S	300.56	11.9	0.590	0.720	0.080	2.420	3.749	2.000
1992 828	14 27 5.1	58.94	149.22	TTY	337.90	11.9	0.380	0.300	0.470	2.810	1.090	1.680
1992 828	14 27 5.1	58.94	149.22	DBI	387.22	12.3	0.280	0.170	0.290	4.050	2.380	---
1992 828	14 27 5.1	58.94	149.22	SUU	431.17	11.6	0.220	0.050	0.270	1.090	1.220	---
1992 828	14 27 5.1	58.94	149.22	ATKR	621.61	11.7	---	---	0.080	0.500	0.240	---
1992 828	14 27 5.1	58.94	149.22	EVE	640.90	11.3	---	---	0.090	0.300	0.120	---
1992 828	14 27 5.1	58.94	149.22	MOMR	890.63	11.8	---	---	0.050	0.380	0.240	---
19921010	17 47 51.4	62.49	154.05	SEY	98.34	10.3	0.150	0.240	0.200	1.000	1.000	---
19921010	17 47 51.4	62.49	154.05	DBI	170.76	10.9	0.100	---	0.120	3.777	1.880	---
19921010	17 47 51.4	62.49	154.05	TL-S	174.65	10.3	0.140	0.090	0.130	1.050	1.030	0.660

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
19921010	17 47 51.4	62.49	154.05	NKB	302.97	9.4	0.020	0.050	0.020	0.150	0.130	0.130
1993 1 2	14 35 42.4	60.70	150.45	MGD	74.32	8.0	---	---	0.100	0.100	0.130	---
1993 1 2	14 35 42.4	60.70	150.45	NKB	113.33	8.3	---	---	0.080	0.110	0.090	---
1993 1 2	14 35 42.4	60.70	150.45	TL-S	115.27	8.2	0.020	0.020	0.050	0.090	0.070	0.050
1993 1 2	14 35 42.4	60.70	150.45	DBI	183.03	8.6	0.040	---	0.050	0.100	0.130	0.080
1993 311	10 45 5.1	62.07	154.11	DBI	176.78	9.7	0.060	0.090	0.090	0.460	0.330	0.100
1993 618	19 16 14.3	62.05	146.22	SUU	128.36	10.4	0.240	0.440	0.460	0.560	0.560	---
1993 618	19 16 14.3	62.05	146.22	ATKR	243.24	10.7	0.416	0.384	0.552	0.748	1.060	0.700
1993 618	19 16 14.3	62.05	146.22	UNIS	317.25	10.8	0.190	0.190	0.070	0.720	0.760	0.950
1993 618	19 16 14.3	62.05	146.22	SSY	348.37	10.6	0.388	0.250	0.390	0.363	0.538	0.345
1993 618	19 16 14.3	62.05	146.22	NZD	373.81	10.7	0.049	0.097	0.100	0.442	0.515	0.757
1993 618	19 16 14.3	62.05	146.22	OMS	496.60	10.5	0.070	---	0.040	0.210	0.250	---
1993 618	19 16 14.3	62.05	146.22	MOMR	512.19	10.5	0.038	0.035	0.060	0.225	0.400	0.143
1994 4 2	16 55 59.8	61.79	153.72	OMS	133.78	9.1	0.090	0.190	0.230	0.150	0.120	0.110
1994 4 2	16 55 59.8	61.79	153.72	SEY	144.72	9.3	0.080	0.080	0.090	0.030	0.280	---
1994 616	17 53 18.2	62.46	147.58	MGD	316.94	12.5	---	---	0.090	6.480	4.890	---
1997 716	20 37 27.9	63.97	144.67	ATKR	32.50	7.7	0.122	0.086	0.108	0.478	0.703	0.343
1997 716	20 37 27.9	63.97	144.67	UNIS	96.16	8.3	0.026	0.026	0.026	0.129	0.143	0.114
1997 716	20 37 27.9	63.97	144.67	NZD	325.25	8.5	---	---	0.015	0.044	0.049	---
1997 730	20 51 15.3	65.66	144.07	UNIS	127.95	9.5	0.057	0.043	0.051	0.641	0.479	0.309
1997 730	20 51 15.3	65.66	144.07	SSY	149.88	9.6	---	0.053	0.050	0.478	0.650	0.375
1997 730	20 51 15.3	65.66	144.07	ATKR	172.05	9.2	0.059	0.027	0.057	0.324	0.338	0.219
1999 1 7	18 13 42.0	67.63	141.62	UNIS	348.48	12.0	0.920	1.220	1.660	4.720	4.680	2.640
1999 1 7	18 13 42.0	67.63	141.62	ATKR	415.45	12.4	2.300	2.340	2.270	3.490	2.840	2.760
199910 4	20 12 43.0	62.85	147.50	ATKR	188.91	10.5	0.310	0.230	0.360	1.310	1.220	1.080
199910 4	20 12 43.0	62.85	147.50	SEY	247.58	11.0	---	---	0.240	1.500	1.290	---

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
199910 4	20 12 43.0	62.85	147.50	UN1S	284.08	10.5	0.170	0.190	0.170	0.840	0.620	0.620
199910 4	20 12 43.0	62.85	147.50	MGD	355.96	10.7	---	---	0.210	0.420	0.630	---
199910 4	20 12 43.0	62.85	147.50	OMS	423.78	10.7	---	---	0.140	0.430	0.340	---
199912 4	11 32 44.5	67.47	129.29	BTG	227.37	10.5	0.258	0.271	0.475	1.308	1.084	1.495
199912 4	11 32 44.5	67.47	129.29	NAY	380.31	11.1	0.530	0.456	0.431	1.850	1.635	1.255
19991224	11 25 25.4	61.49	138.46	ATKR	451.79	10.7	0.032	0.030	0.040	0.690	0.405	0.450
19991224	11 25 25.4	61.49	138.46	UN1S	418.05	10.2	0.044	0.060	0.060	0.380	0.250	0.340
19991224	11 25 25.4	61.49	138.46	CGD	530.38	10.3	0.050	0.074	0.037	0.370	0.250	0.110

Explosions in the Magadan and Northern Yakutia Region

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1985 330	05 59 57.0	63.40	147.00	SEY	275.11	8.6	---	0.020	0.020	0.080	0.030	0.060
1986 1 7	05 45 06.6	63.34	146.60	UNIS	213.82	7.8	0.006	0.011	0.007	0.023	0.034	0.027
1986 110	02 30 38.7	64.70	142.05	UNIS	58.08	7.9	0.035	0.034	0.041	0.173	0.090	0.178
1986 110	02 30 38.7	64.70	142.05	MOMR	203.73	9.1	0.044	0.021	0.063	0.087	0.149	0.063
1986 110	02 30 38.7	64.70	142.05	TBK	401.85	8.7	---	0.006	0.009	0.032	0.038	0.053
1986 110	05 09 56.0	63.14	146.40	UNIS	222.10	7.0	0.006	0.011	0.014	0.046	0.034	0.041
1986 110	05 46 1.5	65.56	150.83	MOMR	358.53	8.1	---	0.011	0.011	0.011	0.021	0.021
1986 110	05 46 1.5	65.56	150.83	UNIS	373.07	8.4	0.006	0.011	0.014	0.023	0.017	0.021
1986 212	04 25 55.4	62.59	147.65	UNIS	310.10	7.2	0.004	0.007	0.006	0.011	0.011	0.013
1986 212	05 06 21.3	62.56	148.16	UNIS	330.70	7.7	0.005	0.005	0.013	0.021	0.011	0.013
1986 212	07 24 08.1	63.77	144.53	UNIS	108.73	6.5	0.003	0.005	0.006	0.011	0.011	0.013
1986 214	07 17 49.0	70.36	133.74	NAY	123.70	7.8	0.039	0.015	0.052	0.051	0.075	0.064
1986 214	07 17 49.0	70.36	133.74	BTG	303.54	7.7	0.013	0.003	0.014	0.026	0.025	0.028
1986 214	07 17 49.0	70.36	133.74	TBK	332.88	7.8	---	0.006	0.009	0.011	0.026	0.018
1986 214	07 17 49.0	70.36	133.74	SAY	186.73	8.0	---	0.007	0.028	0.036	0.059	0.037
1986 216	02 04 22.0	65.20	144.63	UNIS	96.74	7.0	0.005	0.005	0.006	0.021	0.022	0.013
1986 216	02 04 22.0	65.20	144.63	MOMR	154.92	7.5	---	---	0.005	0.022	0.042	0.010
1986 216	02 48 33.5	64.68	144.05	UNIS	41.23	5.8	0.005	0.005	0.008	0.021	0.022	0.013
1986 222	07 29 38.8	69.43	140.17	TBK	257.62	7.4	---	---	0.015	0.018	0.020	0.022
1986 224	06 32 11.5	70.33	133.44	SAY	185.55	7.4	---	---	0.013	0.017	0.025	0.018
1986 3 5	06 13 25.4	64.24	143.12	UNIS	36.61	7.3	0.021	0.021	0.038	0.147	0.172	0.284
1986 321	05 26 07.8	63.36	148.68	UNIS	298.00	8.9	---	---	0.038	0.137	0.140	0.142
1986 4 5	06 57 23.2	71.00	135.00	YUB	49.35	7.6	0.012	0.015	0.021	0.075	0.063	0.086
1986 6 4	06 39 37.3	64.20	150.32	UNIS	343.37	8.6	0.020	0.011	0.020	0.040	0.026	0.080

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1986 620	23 48 23.5	70.77	140.26	YUB	152.65	8.1	---	0.030	0.040	0.050	0.057	0.050
1986 7 9	05 32 18.7	63.38	146.71	UN1S	215.13	8.3	0.019	0.020	0.024	0.073	0.060	0.085
1986 7 9	05 32 18.7	63.38	146.71	MOMR	380.72	7.8	---	0.006	0.010	0.006	0.010	0.010
1986 719	01 16 08.4	63.45	147.00	UN1S	221.83	7.4	0.002	---	0.003	0.020	0.010	0.024
1986 729	05 33 01.6	62.35	130.07	YAK	42.48	8.6	0.197	0.093	0.187	0.878	0.692	0.223
1986 9 3	23 23 14.0	66.60	143.43	MOMR	17.60	7.0	0.300	0.050	0.200	0.450	0.870	0.550
19861212	05 42 26.5	63.35	147.50	UN1S	248.60	7.8	---	---	0.012	0.025	0.014	---
19861223	03 35 49.0	65.06	143.84	UN1S	62.15	6.6	---	---	0.048	0.044	0.035	---
1987 129	05 58 00.0	63.23	148.14	SUU	49.98	7.5	0.071	0.036	0.054	0.214	0.196	0.215
1987 2 3	04 34 51.4	62.86	145.27	SUU	146.55	7.8	0.009	0.018	0.009	0.036	0.036	0.027
1987 2 3	04 34 51.4	62.86	145.27	NKB	250.27	7.8	0.007	0.007	0.007	0.015	0.030	0.007
1987 2 3	06 15 18.0	63.06	148.46	SUU	34.85	6.9	0.071	0.071	0.036	0.107	0.071	0.090
1987 2 3	06 15 18.0	63.06	148.46	SNE	151.30	6.9	0.012	0.006	0.007	0.017	0.012	0.007
1987 2 3	06 15 18.0	63.06	148.46	NKB	192.63	7.1	0.007	0.007	0.007	0.007	0.015	0.007
1987 219	07 49 23.7	63.21	148.15	SUU	47.78	8.0	0.151	0.053	0.108	0.160	0.231	0.152
1987 219	07 49 23.7	63.21	148.15	SNE	174.11	7.1	0.006	0.012	0.007	0.012	0.018	0.015
1987 219	07 49 23.7	63.21	148.15	DBI	164.04	7.7	0.007	0.015	0.015	0.022	0.022	0.015
1987 219	07 49 23.7	63.21	148.15	NKB	211.23	8.8	0.015	0.007	0.022	0.015	0.030	0.022
1987 219	04 43 51.2	62.64	148.12	SUU	15.63	4.8	0.027	0.009	0.009	0.027	0.044	0.027
1987 219	04 43 51.2	62.64	148.12	DBI	139.27	7.1	0.007	0.007	0.007	0.022	0.007	0.007
1987 219	04 43 51.2	62.64	148.12	NKB	149.44	7.2	0.007	0.007	0.007	0.015	0.022	0.015
1987 219	05 12 37.0	64.32	144.55	SUU	247.18	8.4	0.027	0.018	0.027	0.027	0.036	0.027
1987 219	05 12 37.0	64.32	144.55	DBI	379.81	8.3	0.007	0.007	0.015	0.015	0.015	0.015
1987 220	05 02 .	62.64	148.92	UN1S	353.58	8.7	---	---	0.027	0.039	0.022	---
1987 224	04 00 55.6	63.76	147.27	UN1S	215.46	7.8	---	---	0.007	0.045	0.018	---
1987 3 3	02 34 56.5	64.12	143.25	UN1S	49.59	7.7	---	---	0.012	0.226	0.261	---

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1987 3 4	03 52 58.6	64.55	142.02	UNIS	57.76	6.9	---	---	0.024	0.128	0.110	---
1987 3 5	04 34 30.9	64.76	143.79	UNIS	34.37	5.3	---	---	0.004	0.020	0.005	---
1987 3 5	06 37 13.3	64.25	144.26	UNIS	60.79	7.4	---	---	0.024	0.157	0.151	---
1987 3 5	06 37 13.3	64.25	144.26	NZD	324.32	7.6	---	---	0.006	0.018	0.014	---
1987 3 5	06 54 22.8	66.37	136.44	TBK	130.08	8.1	---	---	0.007	0.021	0.101	---
1987 3 6	07 12 23.4	70.32	134.00	YUB	90.73	7.9	---	---	0.026	0.040	0.064	---
1987 3 6	07 12 23.4	70.32	134.00	NAY	134.40	8.0	---	---	0.033	0.030	0.038	---
1987 3 6	09 01 47.7	64.42	144.68	UNIS	71.44	7.5	---	---	0.012	0.098	0.044	---
1987 310	04 20 00.0	62.00	147.00	UNIS	342.04	7.9	---	---	0.012	0.020	0.010	0.024
1987 310	04 42 00.0	62.00	147.00	UNIS	342.04	8.1	---	---	0.005	0.020	0.016	0.016
1987 316	08 18 11.0	66.51	136.27	TBK	115.00	7.7	---	---	0.018	0.035	0.070	---
1987 316	08 18 11.0	66.51	136.27	BTG	145.47	7.1	---	---	0.015	0.017	0.028	---
1987 317	03 33 38.5	64.49	144.54	UNIS	63.36	7.8	---	---	0.012	0.120	0.130	---
1987 317	03 33 38.5	64.49	144.54	SUU	260.61	8.5	0.027	0.018	0.027	0.036	0.036	0.027
1987 317	03 33 38.5	64.49	144.54	NKB	411.94	8.4	0.007	0.007	0.015	0.015	0.015	0.015
1987 317	03 33 38.5	64.49	144.54	DBI	390.73	8.3	0.007	0.007	0.007	0.022	0.015	0.015
1987 317	03 33 38.5	64.49	144.54	SNE	400.94	8.2	0.007	0.007	0.007	0.014	0.014	0.007
1987 317	03 59 27.0	63.12	147.57	SUU	47.78	8.0	0.142	0.036	0.090	0.178	0.187	0.179
1987 317	03 59 27.0	63.12	147.57	DBI	183.94	7.9	0.007	0.015	0.022	0.037	0.022	0.022
1987 317	03 59 27.0	63.12	147.57	SNE	189.87	7.7	0.014	0.014	0.014	0.020	0.034	0.041
1987 317	03 59 27.0	63.12	147.57	NKB	208.57	8.4	0.022	0.015	0.022	0.030	0.067	0.022
1987 317	04 12 06.4	62.75	147.80	SUU	18.10	6.4	0.026	0.044	0.036	0.116	0.133	0.099
1987 317	04 12 06.4	62.75	147.80	DBI	158.10	7.4	0.007	0.007	0.015	0.015	0.015	0.015
1987 317	04 12 06.4	62.75	147.80	SNE	158.45	7.3	0.014	0.007	0.007	0.020	0.020	0.014
1987 317	04 12 06.4	62.75	147.80	NKB	165.85	7.5	0.007	0.007	0.015	0.015	0.022	0.015
1987 317	05 55 34.2	70.24	133.16	NAY	112.63	7.8	---	---	0.024	0.055	0.045	---

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1987 321	03 19 27.8	64.77	143.81	UN1S	35.86	7.2	---	---	0.049	0.147	0.191	---
1987 321	03 19 27.8	64.77	143.81	MOMR	190.71	7.0	---	---	0.006	0.018	0.006	---
1987 321	05 40 49.6	70.35	134.31	NAY	143.37	8.1	---	---	0.020	0.019	0.082	---
1987 321	05 40 49.6	70.35	134.31	YUB	79.17	7.9	---	---	0.033	0.076	0.095	---
1987 321	07 32 52.9	64.32	144.40	UN1S	62.55	7.4	---	---	0.012	0.158	0.121	---
1987 321	07 32 52.9	64.32	144.40	MOMR	245.01	7.8	---	---	0.010	0.037	0.009	---
1987 324	03 34 14.5	64.48	143.57	UN1S	18.92	5.7	---	---	0.061	0.147	0.141	---
1987 324	06 32 39.3	70.89	134.53	YUB	59.65	7.0	---	---	0.027	0.054	0.023	---
1987 325	04 30 15.2	70.39	140.73	TLI	23.08	7.9	---	---	0.027	1.137	0.720	---
1987 325	05 01 44.1	65.88	149.65	SUU	352.29	8.2	0.009	0.009	0.009	0.018	0.018	0.009
1987 325	05 01 44.1	65.88	149.65	SEY	353.05	8.0	0.005	0.005	0.010	0.015	0.015	0.015
1987 325	05 01 44.1	65.88	149.65	SNE	424.14	8.3	0.007	0.007	0.007	0.014	0.020	0.014
1987 328	08 43 33.6	69.17	138.62	TBK	200.81	8.1	0.006	0.017	0.023	0.028	0.040	0.027
1987 4 1	01 36 00.0	63.28	148.12	SEY	217.86	7.7	0.005	0.010	0.010	0.020	0.015	0.020
1987 4 4	01 31 04.4	64.97	143.56	UN1S	47.64	7.5	0.108	0.014	0.024	0.108	0.141	0.134
1987 4 4	04 09 00.0	62.97	147.94	UN1S	291.79	7.7	---	---	0.010	0.020	0.014	---
1987 4 4	04 09 00.0	62.97	147.94	SEY	224.70	8.0	0.005	0.010	0.010	0.035	0.020	0.030
1987 4 6	05 04 45.1	63.47	146.85	UN1S	214.50	7.9	0.008	0.008	0.007	0.043	0.014	0.054
1987 4 6	05 05 41.3	69.92	132.95	YUB	149.02	8.0	---	---	0.017	0.065	0.038	0.030
1987 4 9	08 25 25.7	70.50	134.45	NAY	142.24	7.7	0.013	0.012	0.016	0.028	0.028	0.033
1987 4 9	08 25 25.7	70.50	134.45	YUB	66.42	7.7	---	0.057	0.078	0.120	0.070	0.100
1987 421	23 12 21.7	69.72	133.11	SAY	125.19	7.6	0.023	0.007	0.007	0.036	0.034	0.013
1987 421	23 12 21.7	69.72	133.11	YUB	159.71	8.4	0.030	0.038	0.065	0.056	0.102	0.069
1987 421	23 12 21.7	69.72	133.11	NAY	154.12	7.8	0.013	0.009	0.014	0.025	0.023	0.033
1987 423	05 40 05.3	64.27	142.41	NZD	258.39	8.6	0.026	0.011	0.030	0.069	0.061	0.071
1987 423	05 40 05.3	64.27	142.41	UN1S	51.23	7.6	0.059	0.091	0.061	0.246	0.948	0.719

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1987 423	05 40 05.3	64.27	142.41	MOMR	247.22	8.1	0.011	0.007	0.010	0.059	0.022	0.024
1987 423	05 40 05.3	64.27	142.41	SUU	329.17	8.4	0.018	0.018	0.018	0.027	0.027	0.027
1987 423	05 40 05.3	64.27	142.41	DBI	468.48	8.4	0.007	0.007	0.007	0.015	0.015	0.007
1987 423	05 40 05.3	64.27	142.41	NKB	460.43	8.4	0.007	0.007	0.007	0.015	0.015	0.007
1987 423	05 40 05.3	64.27	142.41	SNE	473.66	8.5	0.007	0.007	0.007	0.014	0.014	0.014
1987 426	02 27 28.0	64.31	144.54	SUU	246.80	10.2	0.178	0.142	0.125	0.605	0.302	0.430
1987 426	02 27 28.0	64.31	144.54	SNE	388.63	8.6	0.014	0.020	0.020	0.020	0.027	0.027
1987 426	02 27 28.0	64.31	144.54	NKB	395.40	8.0	0.015	0.015	0.015	0.015	0.022	0.015
1987 427	06 32 59.7	67.73	138.16	TBK	72.52	7.5	0.015	0.015	0.015	0.079	0.110	---
1987 427	06 32 59.7	67.73	138.16	BTG	149.53	7.7	---	---	0.035	0.038	0.055	---
1987 428	04 24 00.2	64.74	144.05	UN1S	43.70	6.7	---	---	0.012	0.069	0.081	---
1987 428	04 26 13.4	63.49	146.03	UN1S	181.53	6.5	---	---	0.004	0.015	0.008	---
1987 429	23 03 15.1	64.70	143.74	UN1S	28.61	6.5	0.024	0.020	0.024	0.078	0.091	0.157
1987 429	23 03 15.1	64.70	143.74	MOMR	198.01	7.1	---	---	0.010	0.025	0.011	---
1987 430	01 39 31.2	64.29	144.62	UN1S	73.57	8.6	0.005	0.020	0.005	0.216	0.341	0.151
1987 430	01 39 31.2	64.29	144.62	NZD	341.23	7.9	0.007	0.004	0.013	0.028	0.021	0.032
1987 430	01 39 31.2	64.29	144.62	MOMR	250.72	7.8	---	---	0.014	0.087	0.014	---
1987 430	01 39 31.2	64.29	144.62	SUU	242.44	7.8	0.018	0.009	0.009	0.018	0.018	0.036
1987 430	01 39 31.2	64.29	144.62	NKB	391.37	8.1	0.007	0.007	0.007	0.015	0.015	0.015
1987 430	02 13 18.8	69.23	132.84	NAY	197.15	8.1	0.012	0.006	0.020	0.019	0.047	0.067
1987 430	02 13 18.8	69.23	132.84	YUB	208.78	9.1	0.025	0.016	0.065	0.126	0.130	0.095
1987 430	02 13 18.8	69.23	132.84	TLI	324.04	7.7	---	---	0.011	0.032	0.031	0.035
1987 430	07 59 03.2	63.33	146.75	UN1S	220.21	7.7	0.014	0.006	0.007	0.031	0.020	0.005
1987 430	07 59 03.2	63.33	146.75	MOMR	386.61	7.4	---	---	0.008	0.009	0.006	0.010
1987 515	07 25 40.0	63.36	147.25	UN1S	237.79	8.1	0.010	0.010	0.012	0.040	0.020	0.048
1987 521	05 08 51.5	63.25	146.44	UN1S	214.74	7.7	0.010	0.005	0.006	0.025	0.024	0.015

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1987 521	05 08 51.5	63.25	146.44	NZD	383.45	8.5	0.009	0.005	0.011	0.028	0.021	0.043
1987 523	00 26 04.0	65.90	150.11	ZYR	26.65	8.9	0.010	0.010	0.010	2.410	1.931	2.275
1987 523	01 31 20.9	62.10	135.38	NZD	195.26	8.3	0.007	0.005	0.021	0.055	0.043	0.028
1987 524	02 54 37.6	64.95	143.46	UN1S	44.13	6.8	---	---	0.003	0.065	0.052	0.095
1987 524	02 54 37.6	64.95	143.46	MOMR	169.10	7.0	---	---	0.010	0.018	0.008	0.007
1987 526	05 05 03.8	63.42	147.49	UN1S	243.81	7.9	0.011	0.008	0.008	0.022	0.033	0.040
1987 526	21 20 00.7	67.76	140.10	TBK	153.32	8.5	0.011	0.010	0.035	0.089	0.090	0.077
1987 526	21 20 00.7	67.76	140.10	BTG	231.32	7.7	0.010	---	0.008	0.025	0.030	0.020
1987 6 3	05 26 41.2	63.30	146.45	UN1S	211.25	7.7	0.008	0.006	0.007	0.028	0.013	0.029
1987 6 4	08 51 16.1	63.38	146.74	UN1S	216.28	7.8	---	---	0.010	0.036	0.019	0.021
1987 6 5	06 39 09.6	63.21	146.71	UN1S	227.59	7.7	0.008	0.008	0.012	0.026	0.017	0.022
1987 8 1	03 59 47.6	63.26	146.94	UN1S	232.50	8.5	0.036	0.031	0.021	0.050	0.062	0.059
1987 8 1	03 59 47.6	63.26	146.94	ZYR	304.25	8.7	0.021	0.026	0.026	0.064	0.118	0.066
1987 8 1	03 59 47.6	63.26	146.94	MOMR	397.61	8.1	0.006	0.006	0.018	0.034	0.020	0.032
1987 811	01 38 .	63.30	147.10	UN1S	235.87	10.0	0.012	0.012	0.012	0.060	0.042	0.048
1987 811	01 38 .	63.30	147.10	MOMR	396.99	8.2	0.008	0.001	0.008	0.019	0.016	0.018
1987 817	00 55 09.3	69.34	139.29	TLI	110.02	7.8	0.013	---	0.019	0.064	0.045	0.028
1987 917	00 32 42.2	65.94	150.03	ZYR	28.29	8.6	---	---	0.368	1.538	2.200	2.500
1987 917	00 32 42.2	65.94	150.03	MOMR	311.24	6.8	0.006	0.006	0.007	0.007	0.008	0.002
1987 918	05 21 55.2	63.21	146.80	UN1S	230.90	7.6	0.005	0.005	0.005	0.020	0.016	0.024
198710 2	05 51 18.9	63.25	146.56	UN1S	219.07	8.0	0.017	0.024	0.012	0.052	0.031	0.050
19871028	04 25 04.1	63.27	146.67	UN1S	221.59	8.5	0.020	0.024	0.018	0.090	0.047	0.096
19871031	08 25 20.2	62.52	129.88	CGD	421.33	9.8	0.022	0.023	0.024	0.077	0.153	0.047
198711 5	02 32 24.9	62.13	135.77	KHG	58.88	7.0	0.014	---	0.023	0.046	0.078	0.088
198711 6	03 35 54.8	63.76	147.42	UN1S	222.09	7.4	---	---	0.005	0.018	0.013	0.017
198711 6	22 09 08.2	63.08	147.50	UN1S	266.90	7.8	0.014	---	0.010	0.040	0.021	0.044

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
19871119	00 07 43.0	63.40	146.10	UNIS	190.93	8.0	0.011	0.023	0.013	0.040	0.042	0.060
19871120	05 02 25.0	69.34	138.38	BTG	242.40	7.8	0.003	0.005	0.008	0.025	0.021	0.014
19871120	05 02 25.0	69.34	138.38	SAY	171.93	8.8	---	---	0.021	0.048	0.047	0.047
19871121	02 36 27.4	63.20	146.60	MOMR	396.97	8.1	0.010	0.007	0.012	0.028	0.025	0.019
19871123	23 29 06.3	62.02	156.26	SUU	426.23	9.1	0.009	0.009	0.009	0.062	0.044	0.027
19871210	05 24 18.0	69.13	138.82	TLI	139.62	8.2	0.038	0.025	0.034	0.056	0.071	0.050
19871210	05 24 18.0	69.13	138.82	SAY	181.29	8.0	---	0.017	0.012	0.027	0.034	0.027
19871210	05 24 18.0	69.13	138.82	TBK	200.57	8.7	0.010	0.037	0.030	0.053	0.110	0.040
1988 1 9	06 00 33.6	63.67	146.20	UNIS	175.38	7.3	---	0.007	0.006	0.015	0.010	0.024
1988 215	02 28 28.7	70.95	134.19	YUB	73.43	8.0	---	---	0.033	0.166	0.133	0.332
1988 311	04 13 34.4	62.71	148.06	SUU	8.94	5.3	0.196	0.089	0.106	0.196	0.107	0.176
1988 311	04 13 34.4	62.71	148.06	NKB	157.76	7.5	0.010	0.010	0.010	0.019	0.024	0.015
1988 311	04 13 34.4	62.71	148.06	DBI	144.15	7.6	0.007	0.007	0.007	0.037	0.022	0.030
1988 311	04 13 34.4	62.71	148.06	MYA	254.60	7.3	0.008	0.008	0.008	0.008	0.016	0.008
1988 311	05 28 05.8	63.68	147.46	SUU	105.84	9.3	0.142	0.054	0.088	0.267	0.304	0.229
1988 311	05 28 05.8	63.68	147.46	NKB	269.78	8.6	0.019	0.015	0.019	0.058	0.068	0.058
1988 311	05 28 05.8	63.68	147.46	DBI	223.26	8.7	0.022	0.022	0.030	0.105	0.052	0.075
1988 311	05 28 05.8	63.68	147.46	MYA	346.17	8.4	0.008	0.008	0.008	0.033	0.033	0.025
1988 311	05 45 50.2	62.95	149.33	SUU	62.81	7.5	0.018	0.018	0.018	0.080	0.063	0.062
1988 311	05 45 50.2	62.95	149.33	DBI	99.49	7.8	0.007	0.007	0.007	0.067	0.045	0.045
1988 311	05 45 50.2	62.95	149.33	MYA	222.99	8.1	0.017	0.025	0.025	0.028	0.033	0.033
1988 424	06 47 42.8	63.87	143.00	UNIS	78.21	7.7	0.040	---	0.054	0.071	0.142	0.100
1988 424	06 47 42.8	63.87	143.00	SUU	284.17	8.0	0.018	0.009	0.009	0.027	0.018	0.018
1988 429	07 06 41.8	63.50	147.34	SEY	260.41	7.9	0.005	0.005	0.010	0.025	0.015	0.020
1988 518	03 25 22.3	63.27	146.70	UNIS	222.71	7.6	0.001	0.006	0.006	0.030	0.015	0.029
1988 518	03 25 22.3	63.27	146.70	SEY	288.31	8.1	0.010	0.010	0.010	0.035	0.015	0.020

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
1988 520	01 28 56.0	69.14	138.72	TLI	140.82	7.7	0.011	0.006	0.015	0.038	0.023	0.014
1988 521	04 37 1.1	63.30	146.64	UN1S	218.25	7.8	0.005	0.005	0.012	0.030	0.016	0.024
1988 521	04 37 1.1	63.30	146.64	SEY	291.60	7.7	0.005	0.005	0.005	0.020	0.010	0.015
1988 521	04 37 1.1	63.30	146.64	SUU	95.56	7.3	0.009	0.009	0.009	0.027	0.027	0.026
1988 526	03 28 13.7	63.19	146.58	UN1S	224.42	7.3	---	---	0.006	0.010	0.010	0.012
1988 526	03 28 13.7	63.19	146.58	NZD	389.39	7.4	---	---	0.006	0.028	0.021	0.025
1988 621	01 41 7.1	63.34	146.71	ATKR	121.48	7.4	0.017	---	0.021	0.026	0.028	0.025
1988 621	01 41 7.1	63.34	146.71	UN1S	217.98	8.1	0.008	0.010	0.009	0.050	0.031	0.038
1988 621	01 41 7.1	63.34	146.71	SEY	288.58	7.7	0.008	0.010	0.009	0.025	0.015	0.020
1988 623	02 42 6.9	63.15	146.58	ATKR	135.05	8.9	0.053	0.025	0.141	0.252	0.151	0.161
1988 623	02 42 6.9	63.15	146.58	UN1S	227.56	8.9	0.042	0.065	0.037	0.125	0.065	0.200
1988 623	02 42 6.9	63.15	146.58	SEY	293.50	8.6	0.005	0.020	0.025	0.070	0.070	0.065
1988 717	23 08 0.4	63.43	145.47	UL2S	222.41	8.8	0.026	0.033	0.015	0.200	0.220	0.064
1988 717	23 08 0.4	63.43	145.47	UL1S	242.90	8.0	0.013	---	0.014	0.053	0.039	0.035
1988 8 8	02 37 48.3	64.23	150.03	ZYR	165.98	8.6	0.046	---	0.055	0.080	0.085	0.032
1988 8 8	02 37 48.3	64.23	150.03	SEY	185.33	8.1	0.010	0.010	0.010	0.050	0.050	0.045
1988 920	07 39 21.5	63.19	146.57	SSY	220.33	9.1	0.018	0.021	0.043	0.085	0.174	0.122
1988 920	07 39 21.5	63.19	146.57	UN1S	224.06	9.0	---	0.084	0.050	0.142	0.098	0.128
1988 920	07 39 21.5	63.19	146.57	SEY	294.20	8.7	0.008	0.023	0.015	0.076	0.030	0.045
1988 924	06 39 26.4	64.22	149.11	SSY	142.35	7.8	0.004	---	0.022	0.033	0.023	0.053
19881025	04 23 2.6	63.82	147.52	SSY	150.41	8.1	0.014	0.011	0.044	0.056	0.052	0.086
19881029	01 12 55.6	63.68	147.52	ATKR	129.28	7.5	0.005	0.010	0.012	0.013	0.028	0.029
198811 2	02 58 14.4	63.62	147.48	ATKR	130.69	7.5	---	0.016	0.013	0.023	0.034	0.028
198811 2	02 58 14.4	63.62	147.48	SSY	172.24	7.6	0.008	---	0.024	0.014	0.032	0.049
198811 2	02 58 14.4	63.62	147.48	SEY	256.76	8.0	0.008	0.008	0.015	0.023	0.023	0.023
198811 3	06 16 17.6	63.67	147.20	SSY	165.69	7.2	0.004	---	0.019	0.010	0.022	0.027

Date	Origin Time	Lat.	Long.	Station	Dist. (km)	K	Pg NS	Pg EW	Pg Z	Sg NS	Sg EW	Sg Z
19881114	04 01 37.2	70.14	133.10	SAY	168.66	7.8	0.024	---	0.020	0.020	0.040	0.039
19881119	04 32 40.2	60.03	137.73	NZD	283.51	8.5	---	---	0.016	0.020	0.037	0.031
19881124	02 38 42.0	63.49	147.46	SEY	254.35	8.0	0.008	0.008	0.008	0.030	0.023	0.023
19881126	07 02 27.4	63.09	148.17	SEY	213.30	8.0	0.005	0.010	0.010	0.035	0.030	0.030
19881129	07 03 9.8	63.08	147.02	ATKR	153.88	7.6	0.010	0.015	0.005	0.038	0.016	0.013
198812 2	02 48 18.7	60.42	137.62	NZD	243.40	7.8	---	---	0.005	0.017	0.022	0.031
198812 7	04 01 6.9	63.60	147.21	SSY	173.48	7.3	0.005	0.005	0.010	0.009	0.017	0.044
198812 7	05 28 39.0	64.34	144.36	SSY	157.74	7.2	---	---	0.011	0.015	0.014	0.021
19881210	02 44 54.3	63.68	147.54	SSY	165.97	8.3	0.004	0.008	0.026	0.022	0.083	0.049
19881230	03 19 56.7	63.22	147.04	SEY	270.88	8.6	0.015	0.029	0.029	0.059	0.044	0.044
1993 4 8	04 06 55.1	66.31	136.42	BTG	168.27	8.2	0.027	0.015	0.028	0.084	0.100	0.085
1993 4 8	04 06 55.1	66.31	136.42	TBK	136.79	8.2	0.026	0.017	0.045	0.099	0.091	0.100
199612 5	06 54 17.0	63.22	147.08	ATKR	143.61	7.9	---	---	0.024	0.044	0.060	---
1997 121	04 29 25.4	63.17	146.85	BTG	751.79	8.4	---	---	0.004	0.140	0.140	0.080

APPENDIX B

Graphs for Individual Station

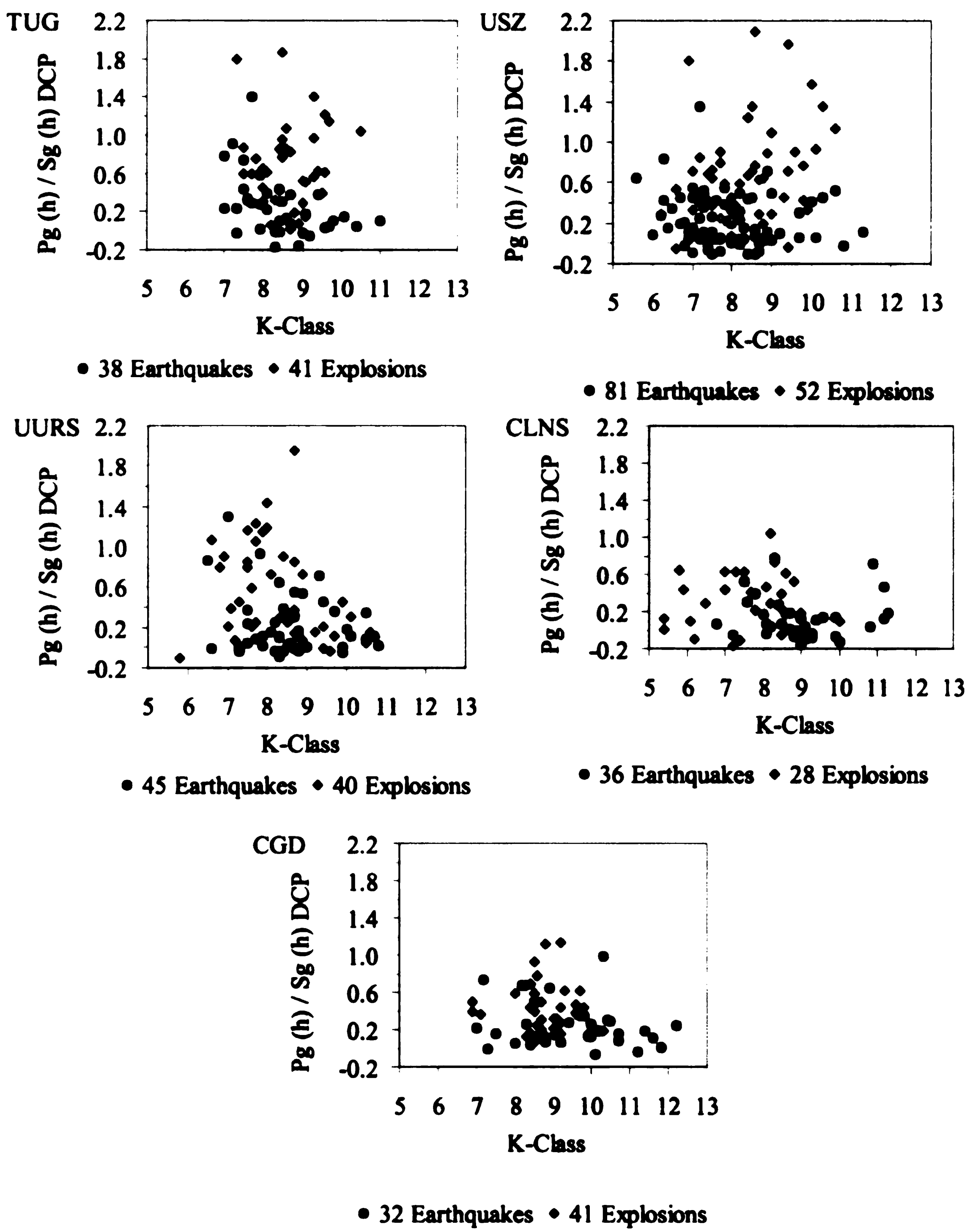

Figure B1. Pg(h)/Sg(h) DCP ratio for stations in the Southern Yakutia region.

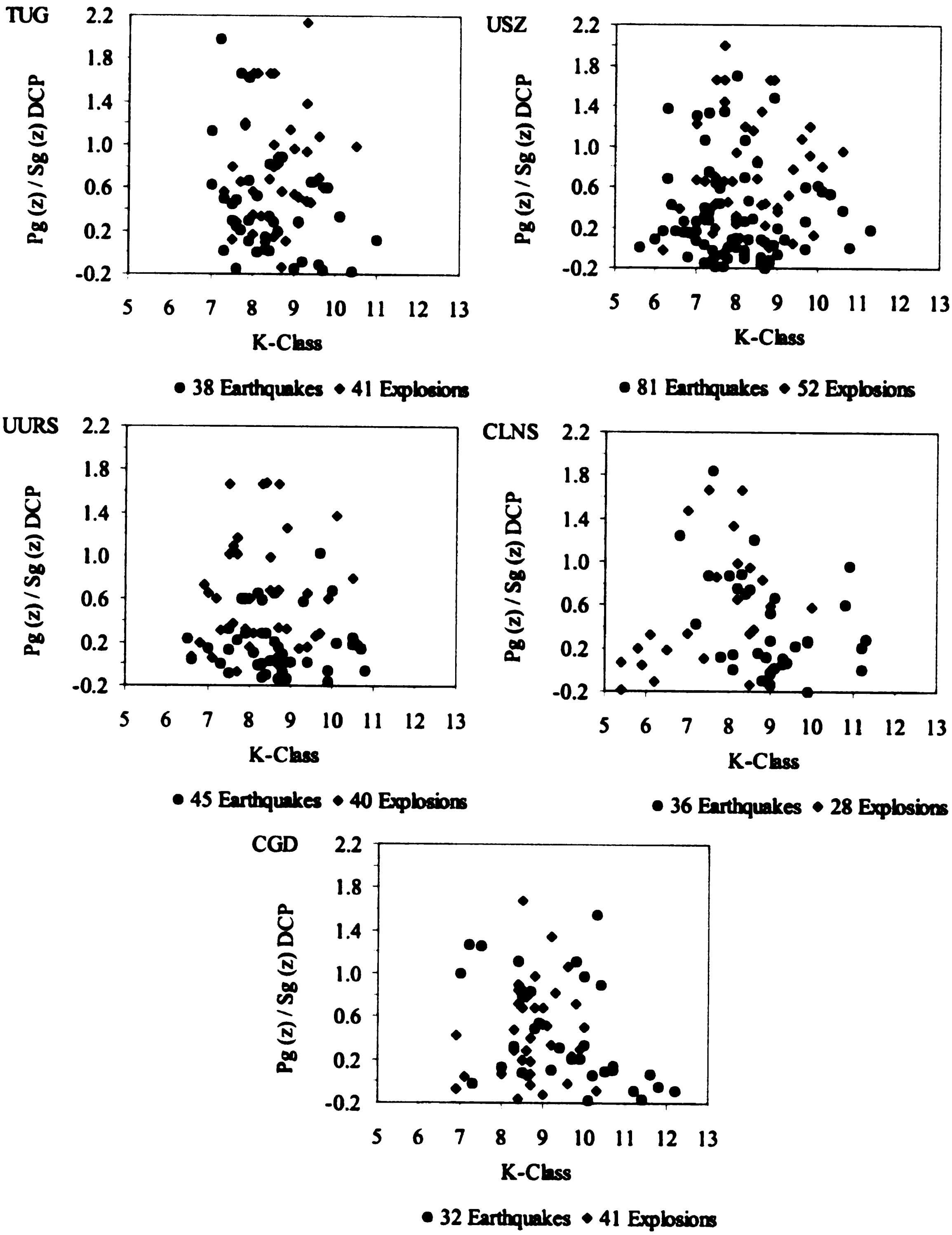

Figure B2. Pg(z)/Sg(z) DCP ratio for stations in the Southern Yakutia region.

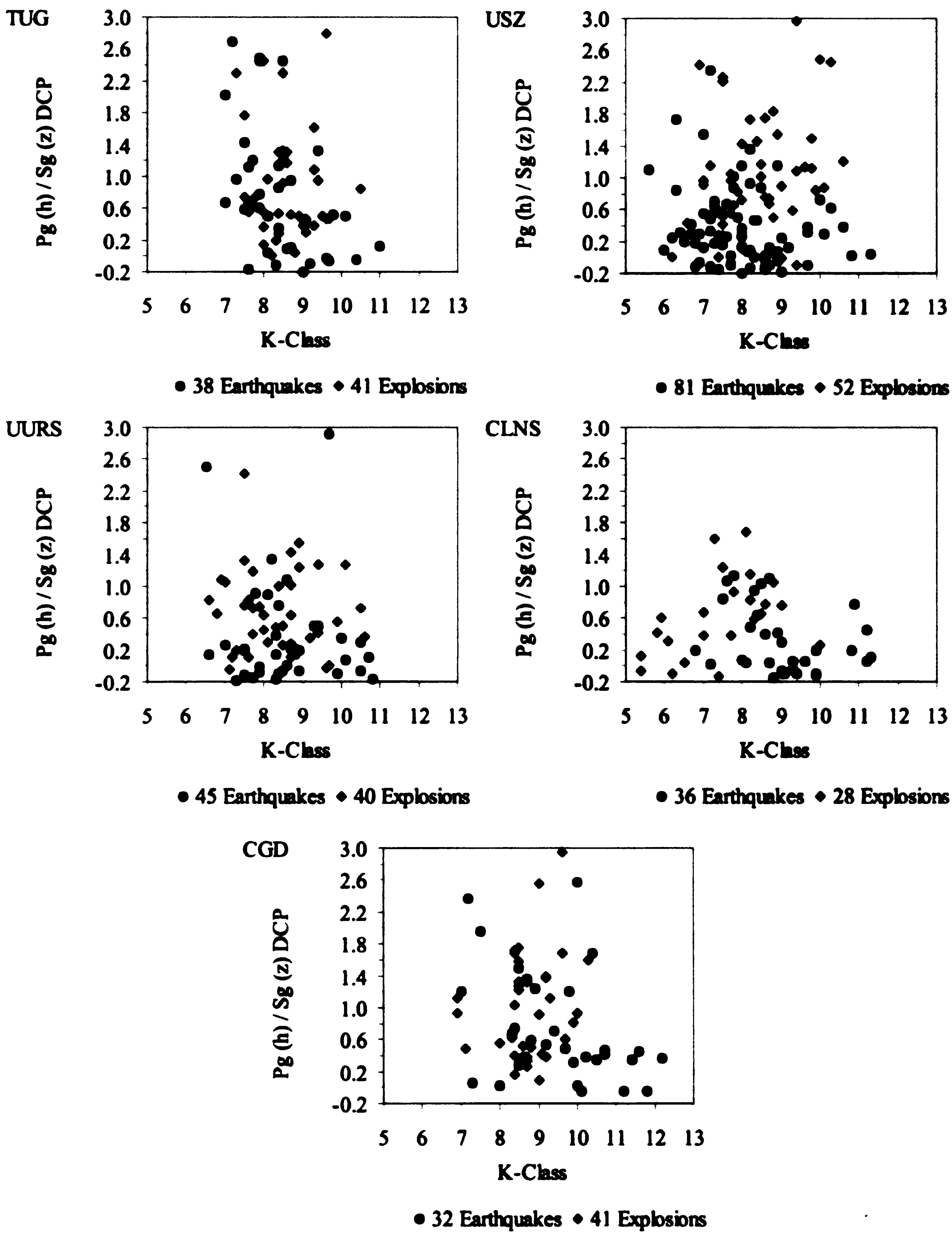

Figure B3. Pg(h)/Sg(z) DCP ratio for stations in the Southern Yakutia region.

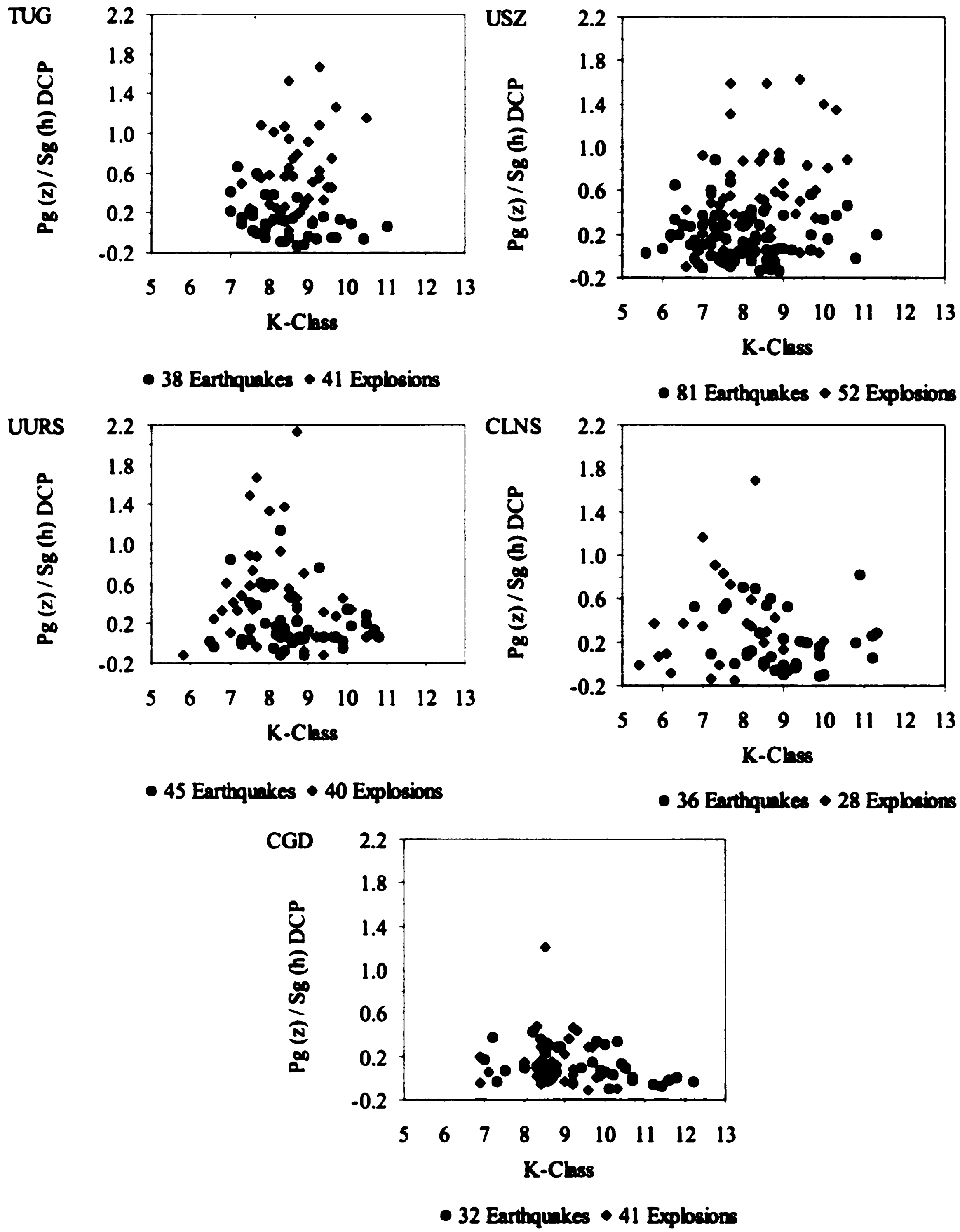

Figure B4. Pg(z)/Sg(h) DCP ratio for stations in the Southern Yakutia region.

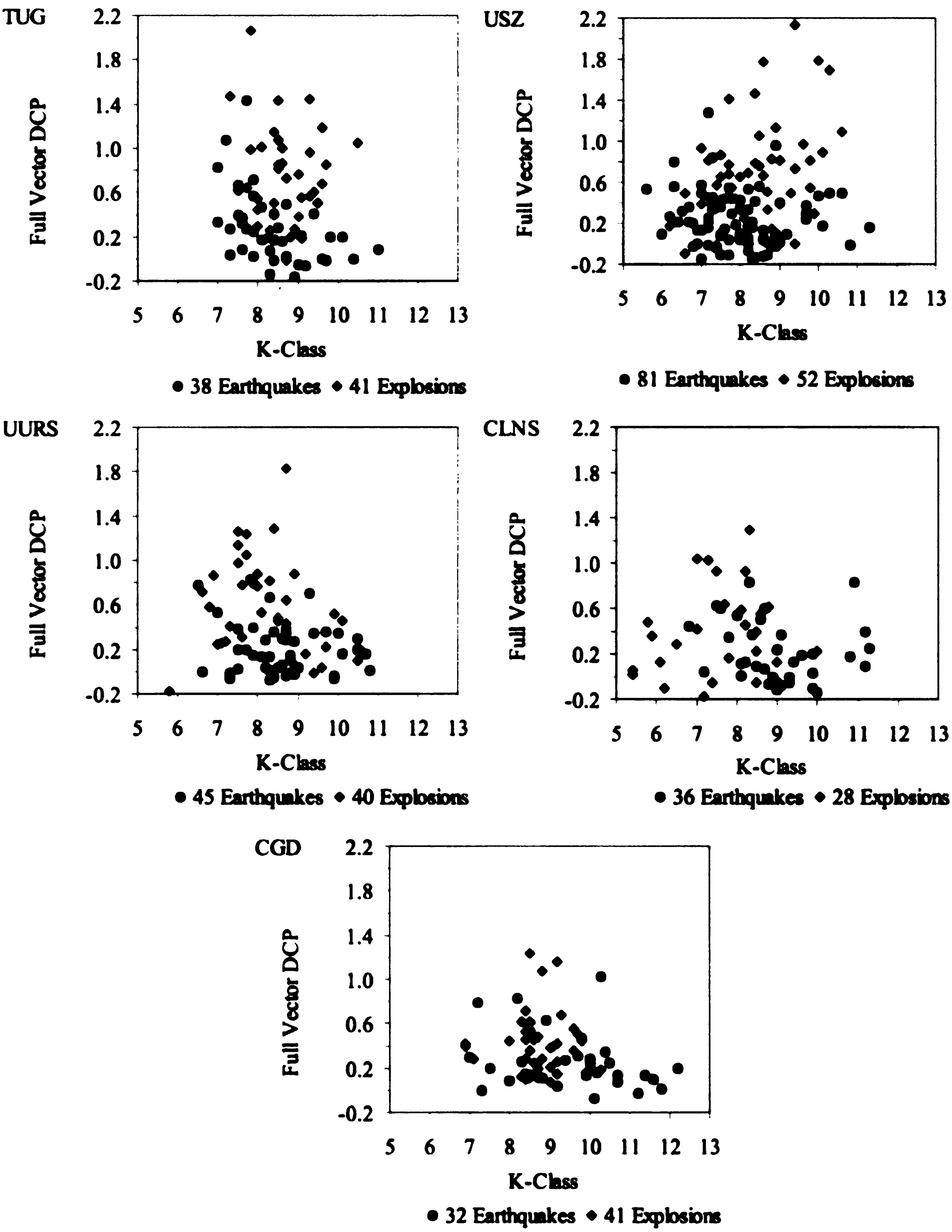

Figure B5. Full vector DCP ratio for stations in the Southern Yakutia region.

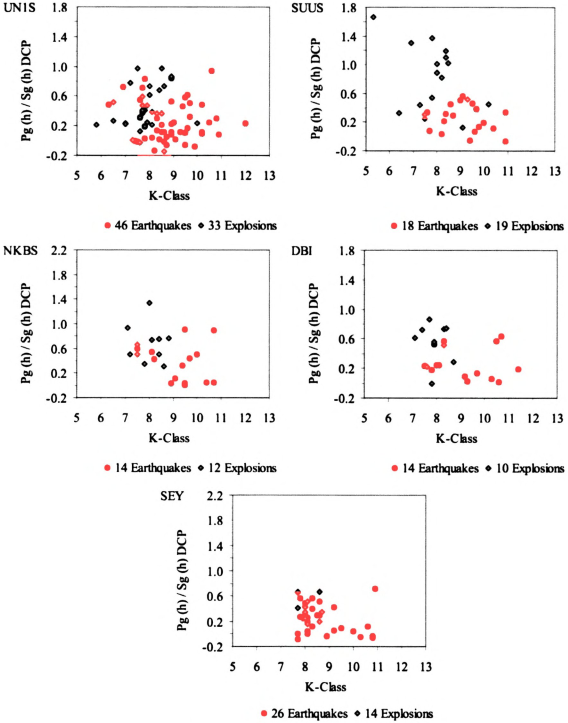

Figure B6. Pg(h)/Sg(h) DCP ratio for individual stations in the Magadan and Northern Yakutia region.

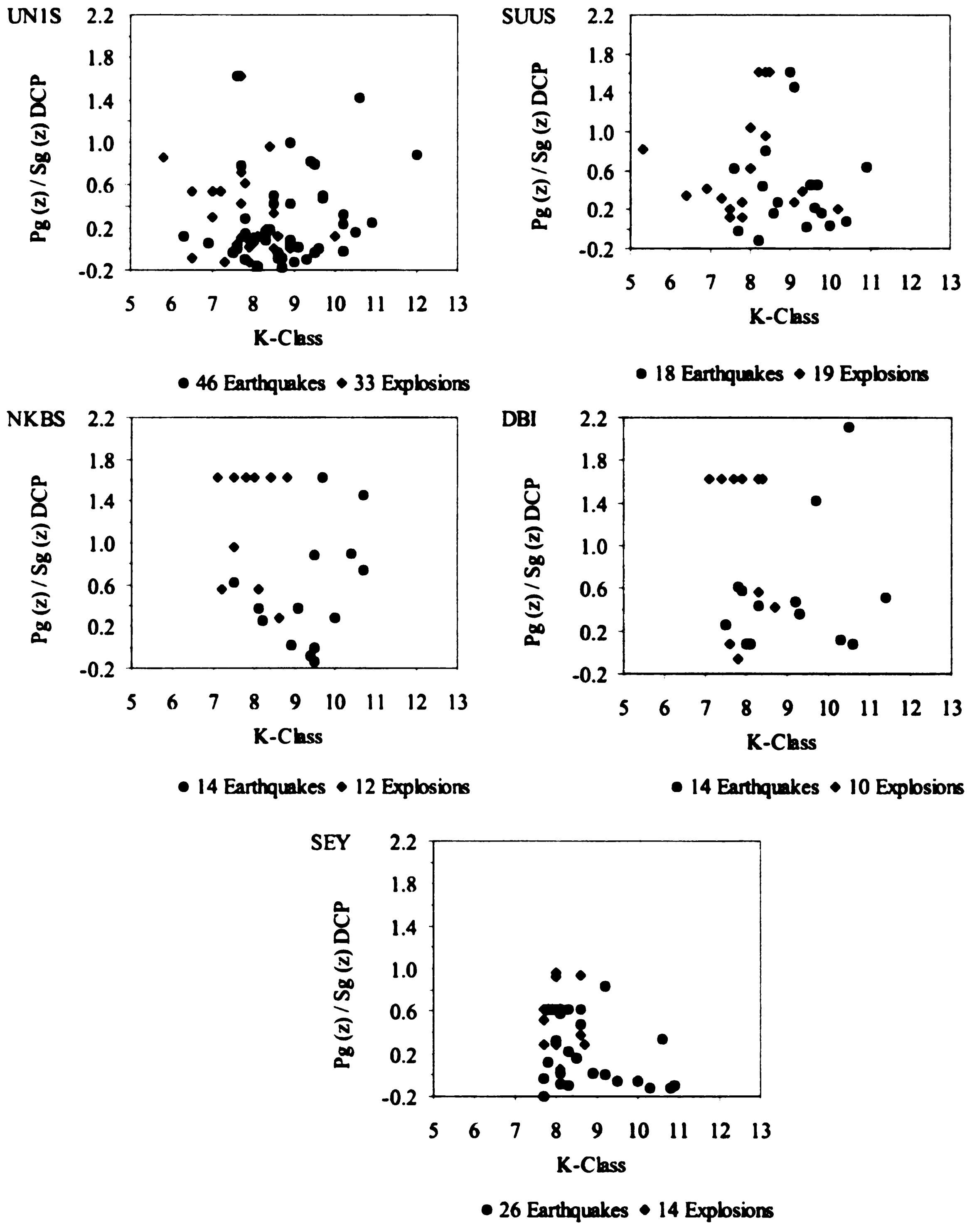

Figure B7. Pg(z)/Sg(z) DCP ratio for individual stations in the Magadan and Northern Yakutia region.

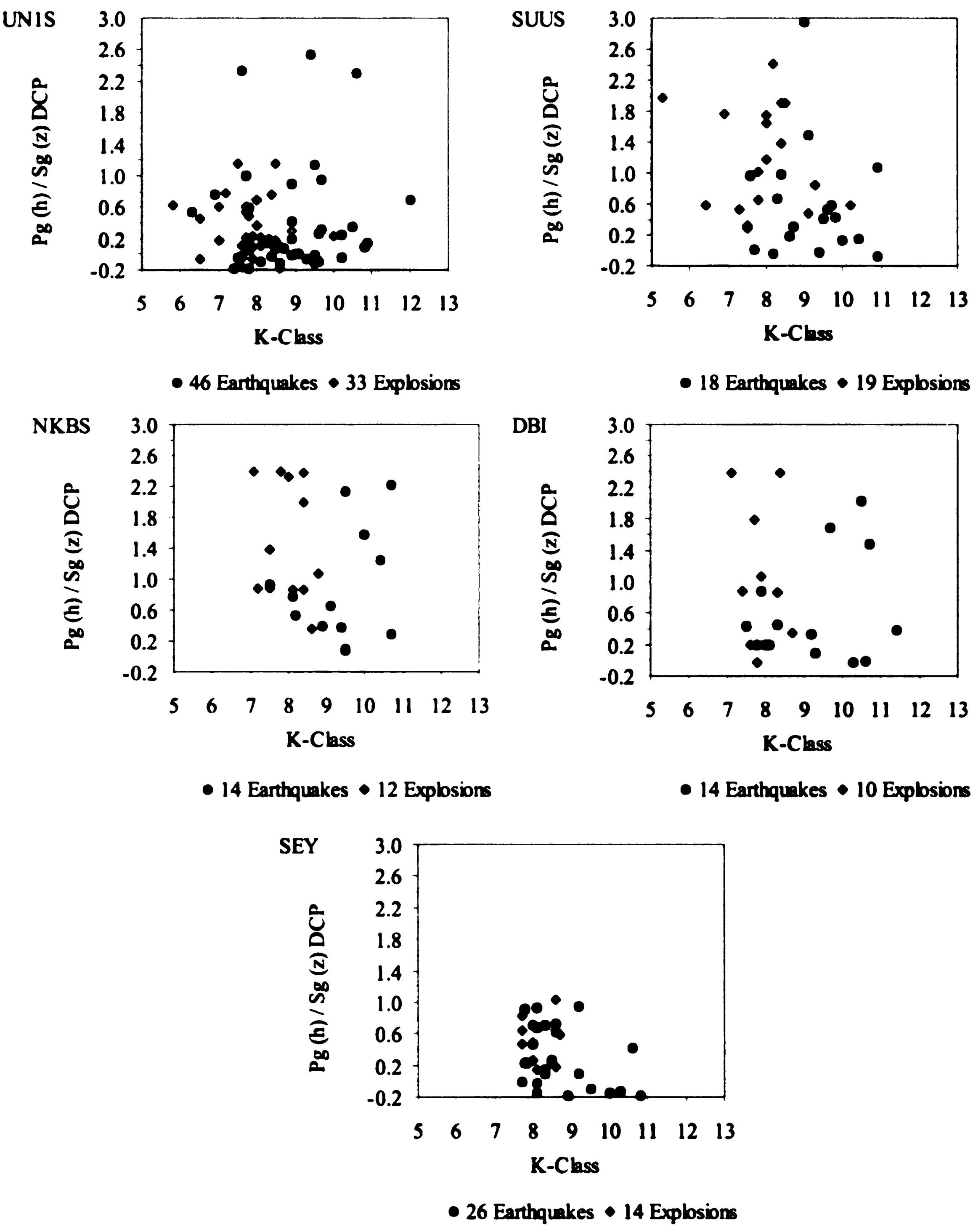

Figure B8. Pg(h)/Sg(z) DCP ratio for individual stations in the Magadan and Northern Yakutia region.

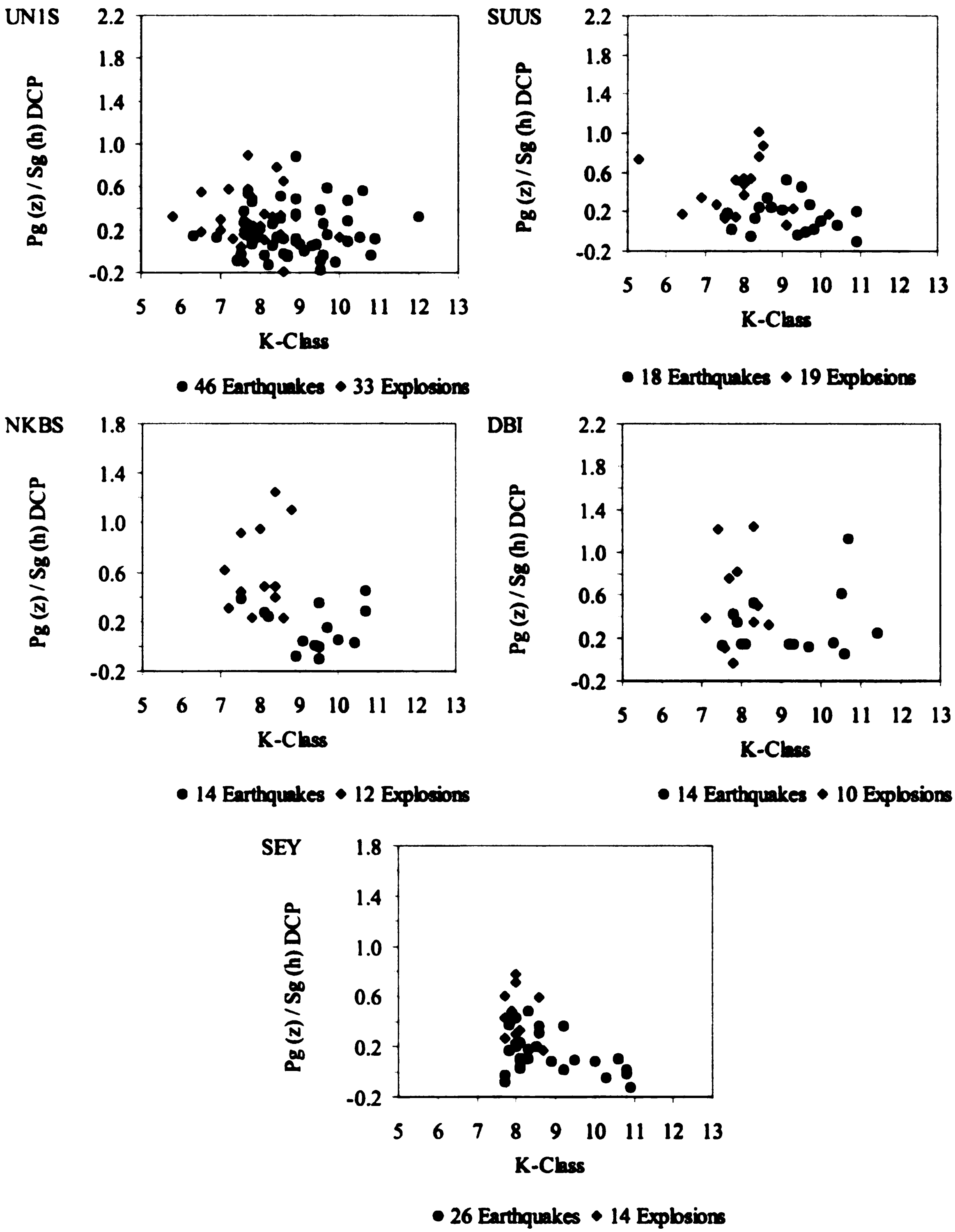

Figure B9. Pg(z)/Sg(h) DCP ratio for individual stations in the Magadan and Northern Yakutia region.

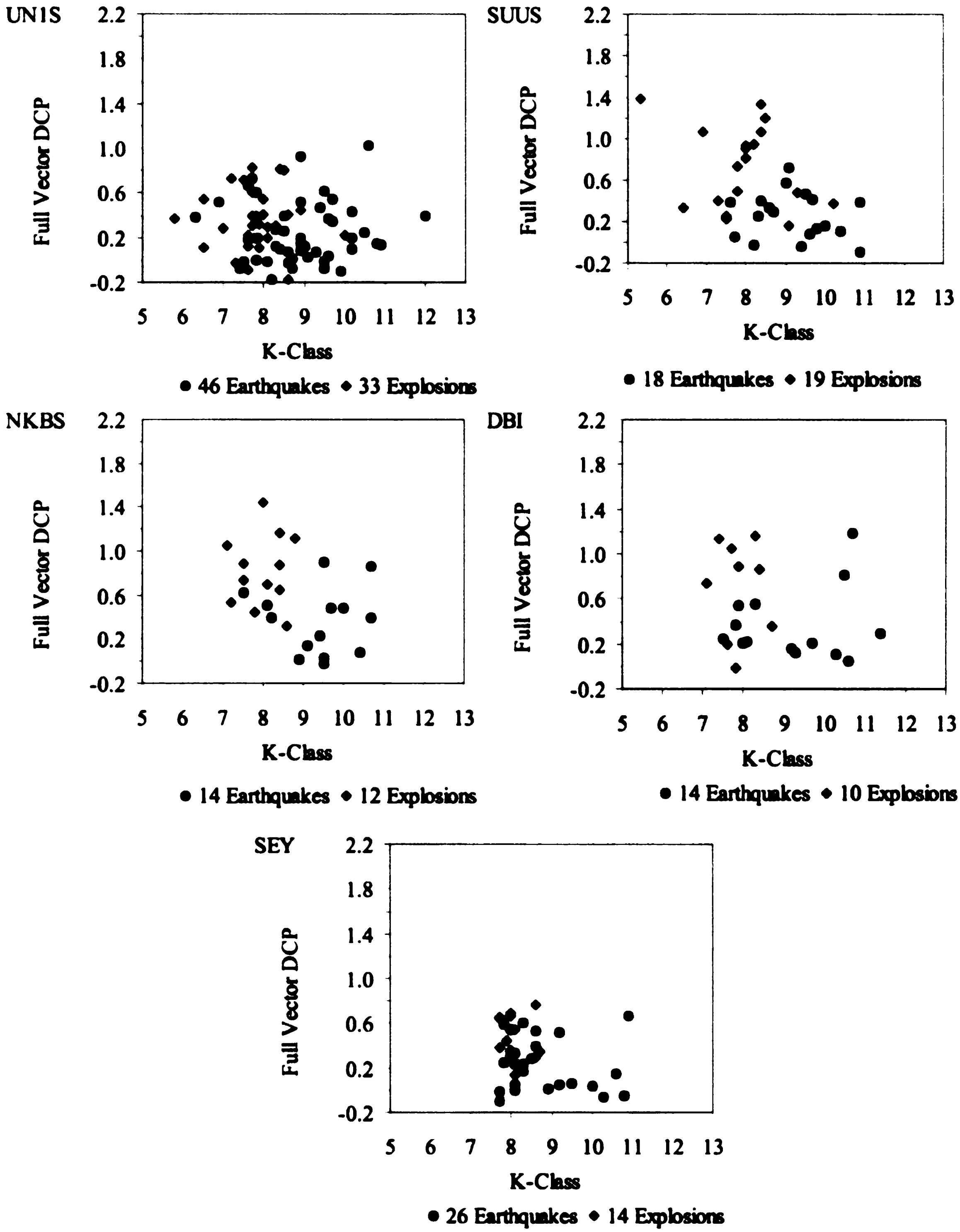

Figure B10. Full vector DCP ratio for individual stations in the Magadan and Northern Yakutia region.