An earthquake focal mechanism catalog for source and tectonic studies in Mexico from February 1928 to July 2022

Quetzalcoatl Rodríguez-Pérez[1], **Francisco Ramón Zúñiga**[2]

[1] Dirección de Desarrollo Científico, Consejo Nacional de Ciencia y Tecnología, Mexico City, Mexico

[2] Centro de Geociencias, Universidad Nacional Autónoma de México, Juriquilla, Querétaro, Mexico

Correspondence: Quetzalcoatl Rodríguez-Pérez (quetza@geociencias.unam.mx)

Abstract. We present a focal mechanism catalog for earthquakes that occurred in Mexico and surrounding areas reported from February 1928 to July 2022. The magnitude of the events varies from -0.9 to 8.2. The hypocentral depth is in the range of $0 < Z < 270$ km. Focal mechanisms in this catalog are associated with tectonic, geothermal, and volcanic environments. Reported focal mechanisms were derived using different types of data at local, regional, and teleseismic distances and different methods such as first motions, composite solutions, waveform analysis, and moment tensor inversion. So far, focal mechanism data for earthquakes in Mexico are dispersed over many publications without any link among them. For this reason, we collect and revise focal mechanism solutions previously reported by different agencies and studies from published sources. Our catalog consists of 7664 focal mechanism solutions for a total of 5701 events since we report all the available focal mechanisms obtained by different authors and seismological agencies for each seismic event. Additionally, we classify the focal mechanisms according to their fault types using the ternary diagrams of Kaverina-type classification. We also rank the quality of the focal mechanism data into three categories: A, B, and C. A represents good/reliable data, B represents regular, and C represents poor/questionable data according to a well-defined criterion. The main goal of this study is to provide a comprehensive compilation of focal

mechanism data that can help in future source and tectonic studies in Mexico.

The earthquake focal mechanism catalog described in this article is available at https://doi.org/10.6084/M9.FIGSHARE.21663668.V1 (Rodríguez-Pérez and Zúñiga, 2022).

1 Introduction

Earthquake catalogs are used in several tasks by seismologists daily. In most cases, seismic catalogs contain essential information such as origin time, hypocentral location, and magnitude of the events in a particular region. In other cases, the catalogs also include specific information such as fault planes, source duration, seismic wave phases, seismic source parameters, and finite-fault models (e.g., Ekström et al., 2012; Mai and Thingbaijam, 2014; Vallé and Douet, 2016; Di Giacomo et al., 2018; Rodríguez-Pérez et al., 2018). Studies related to seismicity and seismic hazard often require as input a seismic catalog that, in ideal conditions, contains information that has been derived in a homogenous way using the same procedures over some time (Cornell, 1968). Combining different datasets, and methods used to estimate a specific parameter, such as location or focal mechanism, can be an alternative form to increase the number of observations and enhance the resolution of an earthquake catalog. However, when combining different datasets, it is important to know the type and quality of data used and the advantages and limitations of the methods used to obtain a parameter reported in the catalogs. This study is focused on a compilation of an extensive earthquake focal mechanism catalog. Focal mechanisms describe the spatial fault orientation where earthquakes occur and the slip direction. Fault plane solutions are essential to understanding seismotectonic processes, such as studying the stress field in a given region. There are different methods available for determining focal mechanisms. One of the most common is based on *P*-wave polarities (Knopoff and Gilbert, 1960). The moment tensor inversion was introduced later, becoming one of the most popular methods nowadays (e.g., Dziewonski et al., 1981; Pasyanos et al., 1996; Guilhem and Dreger, 2011).

Generally, the seismic source is considered as a point source located at the hypocenter, but in other cases, the source can be assumed as a centroid. The size of the earthquake plays an essential role in the source representation (Dziewonski and Woodhouse, 1983). For example, the difference between the centroid and the location of the rupture initiation can be significant. As a result, focal mechanisms derived from wave polarities and moment tensors differ not only from inadequate velocity models or systematic errors. Focal mechanisms derived from *P*-wave polarities represent the geometry of the fault at the beginning of the rupture. On the contrary, the moment tensor solutions provide the source mechanism of the predominant component of the seismic rupture. The difference between wave polarities and moment tensors is more drastic in the cases where the source deviates from a pure double couple representation. Nevertheless, the seismic polarity method is still in use despite its limitations, which can include incorrect polarity readings, inaccurate velocity models, and poor azimuthal coverage of stations, due to its simplicity and affordability. First motion polarities are often the only method to derive focal mechanisms for small to moderate earthquakes (e.g., seismic swarms and aftershock sequences).

As a general practice, seismological observatories routinely compute moment tensors for earthquakes above a certain threshold of magnitude and publish their solutions in online catalogs. The threshold magnitudes of some of these agencies are $M_{\mathrm{W}} = 5.0$ for the Global Centroid Moment Tensor (CMT) project (Dziewonski et al., 1981; Ekström et al., 2012), $M_{\mathrm{W}} = 4.5$ for the GEOFON Global Seismic Network, and $M_{\mathrm{W}} = 5.5$ for the National Earthquake Information Center (NEIC) of the USGS (Benz, 2017). Similarly, there are local and regional moment tensors catalogs with lower threshold magnitudes

($3.5 < M_W < 4.5$). Some other online databases, such as the focal mechanism bulletin of the International Seismological Centre (ISC) (Lentas and Harris, 2019; Lentas et al., 2019) contain both moment tensor solutions and wave polarities of global seismicity. Focal mechanisms have been computed and published in previous studies investigating seismotectonic features of specific regions. Several authors have made a considerable effort to determine focal mechanisms reported in different documents and also collect them in catalogs for specific areas to provide a set of revised information (e.g., Whidden and Pankow, 2012; Franco et al., 2020; Saraò et al., 2021). Many focal mechanism solutions are commonly spread in different documents and locations, making standardizing information, checking, and selecting parameters a painstaking job.

In Mexico, seismological agencies responsible for providing information about earthquakes must report focal mechanisms. The parameters routinely reported are the hypocentral location, magnitude, and origin time. This fact highlights the need to have a robust focal mechanism catalog. For this purpose, we study earthquakes with focal mechanisms in the region corresponding to the Mexican territory and surrounding areas (latitude 12 – 33^{o} N and longitude 120 – 88^{o} W). Mexico is one of the most seismically active regions in the World, where different tectonic environments concur (subduction zone, transform fault zones, and intraplate regions). In Mexico, most of the seismic activity is due to the interaction among five tectonic plates (North American, Pacific, Cocos, Rivera, and Caribbean plates) and, to a lesser extent but not exempt of importance in terms of hazard, to the intraplate stresses located inland at tectonic plates. The region has experienced several shallow crustal intraplate, thrust subduction zone, and intra-slab earthquakes of great magnitude ($7.0 < M < 8.2$) over the past century, causing extensive damage to the population centers as in the case of the 12 November 1912 Acambay earthquake ($M \sim 7.0$), the 19 September 1985 Michoacan earthquake ($M = 8.2$), and the 19 September 2017 ($M = 7.1$) among others.

In virtue of the relevant seismic hazard in the region and its importance from the geodynamical perspective, many authors have computed the focal mechanisms of seismic events using different data and several techniques (e.g., Molnar and Sykes, 1969; Dean and Drake, 1978; Chael and Stewart, 1982; LeFevre and McNally, 1985; Goff et al., 1987; Guzmán-Speziale et al., 1989; Doser and Rodriguez, 1993; Pacheco et al., 1993; Pardo and Suárez, 1993; Pardo and Suárez, 1995; Quintanar et al., 1999; Rebollar et al., 1999; Quintanar et al., 2004; Rodríguez-Lozoya et al., 2008; Ortega and Quintanar, 2010; Pacheco and Singh, 2010; Sumy et al., 2013; Dougherty and Clayton, 2014; Abbott and Brudzinski, 2015; Rodríguez-Pérez and Singh, 2016; Huesca-Pérez et al., 2022). National and International observatories also provide focal mechanism solutions for seismic events generated in the territory of Mexico (e.g., the Mexican Seismological Service, SSN; the Southern California Seismic Network, SCSN; U.S. Geological Survey, USGS, among others). In this study, we aim to collect and revise as many focal mechanisms as possible over time in a comprehensive catalog that can be a great starting point for future seismotectonic and seismic hazard studies.

2 Data and methods

2.1 Data

To collect information on focal mechanisms in Mexico, we first conduct a bibliographic search in libraries retrieving documents such as theses and reports. Secondly, the individual published articles are found via different search engines such as google scholar, research gate, and Geoscienceworld. Finally, we search for focal mechanism solutions in catalogs reported by different seismic agencies. After examining information from several literature references and seismological agencies catalogs, we find 5701 earthquakes with at least one fault plane solution. We report all the available focal mechanisms obtained by different authors and seismological agencies for each seismic event making 7664 the total number of focal mechanisms. The compiled catalog has focal mechanism data from February 1928 to July 2022; the lowest data density is in the time interval of 1928-1970 (125 focal mechanisms) (upper panel in Fig. 1). Then, the number of focal mechanisms increased gradually between 1970 to 1995 (860 focal mechanisms) (Fig. 1). Since 1995, the number of focal mechanisms reported in Mexico has increased significantly (6679 focal mechanisms) (Fig. 1). The magnitude of these events fluctuates from -0.9 to 8.2, while the hypocentral depth is in the interval of $0 < Z < 270$ km. The negative magnitude values are associated with microearthquakes in Sonora, located by Natali and Sbar (1982). These microearthquakes were detected using a 10-station temporal seismic network with the Hypoellipse program (Lahr, 1979). We classify the focal mechanisms into three categories regarding the general geological nature: 1) tectonic or regular, 2) geothermal, and 3) volcanic events.

In our catalog, tectonic earthquakes comprise 7459 focal mechanisms reported in previous studies and for different seismological observatories using different data and methods (Molnar and Sykes, 1969; Thatcher and Brune, 1971; Molnar, 1973; Johnson et al., 1976; Jimenez-Jimenez, 1977; Dean and Drake, 1978; Ebel et al., 1978; Jimenez, 1978; Kanamori and Stewart, 1978; Yamamoto, 1978; Reyes et al., 1979; Astiz, 1980; Morales-Matamoros, 1980; Zúñiga and Valdés-González, 1980; Chael and Stewart, 1982; Frohlich, 1982; Natali and Sbar, 1982; Domínguez-Reyes, 1983; Havskov et al., 1983; Astiz and Kanamori, 1984; Beroza et al., 1984; Burbach et al., 1984; González and Suárez, 1984; González et al., 1984; Lesage, 1984; Munguía and Brune, 1984; Yamamoto et al., 1984; LeFevre. and McNally, 1985; Singh et al., 1985; González-Ruiz, 1986; Mota-Palomino et al., 1986; Ruiz-Kitcher, 1986; Suárez and Ponce, 1986; Yamamoto, 1986; Goff et al., 1987; González-Ruiz, 1987; Yamamoto and Mota, 1988; Yamamoto and Mitchell, 1988; Guzmán-Speziale et al., 1989; Domínguez-Rivas, 1991; Doser, 1992; Doser and Rodriguez, 1993; Pacheco et al., 1993; Pardo and Suárez, 1993; Singh and Pardo, 1993; Wolfe et al., 1993; Zúñiga et al., 1993; Cocco et al., 1994; Ruff and Miller, 1994;

Santoyo-García-Galeano, 1994; Delgado-Vazquez, 1995; Pardo and Suárez, 1995; UNAM and CENAPRED Seismology group, 1995; Wong et al., 1997; Pacheco and Singh, 1998; Quintanar et al., 1999; Rebollar et al., 1999; Singh et al., 1999; Terán-Mendieta, 1999; Campos-Enriquez et al., 2000; Cruz-Jiménez, 2000; Singh et al., 2000a,b; Delgadillo-Peralta, 2001; Rebollar et al., 2001; Iglesias et al., 2002; Yamamoto et al., 2002; Chavacán-Ávila, 2003, Pacheco et al., 2003; Sánchez-Alvaro, 2003; Singh et al., 2003; Zúñiga et al., 2003; Aguilar-Rosales, 2004; García et al., 2004; Núñez-Cornú et al., 2004; Quintanar et al., 2004; Hurtado-Díaz, 2005; Bernal-Esquia, 2006; González et al., 2006; Chavacán-Ávila, 2007; Singh et al., 2007a,b; Huesca-Pérez, 2008; Rodríguez-Lozoya et al., 2008; Ortega and Quintanar, 2010; Pacheco and Singh, 2010; Pérez-Campos et al., 2010; Rodríguez-Lozoya et al., 2010; Vidal et al., 2010; Jaramillo and Suárez, 2011; Martínez-López, 2011; Okal and Borrero, 2011; Stella-Ramírez, 2011; Singh et al., 2012; Soto-Peredo, 2012; Bello-Segura, 2013; Clemente-Chavez et al., 2013; Franco et al., 2013; Rutz-López et al., 2013; Sumy et al., 2013; UNAM Seismology Group, 2013; Yamamoto et al., 2013; De la Vega, 2014; Dougherty et al., 2014; Abbott and Brudzinski, 2015; Singh et al., 2015; Suárez and López, 2015; UNAM Seismology Group, 2015; Yamamoto and Jiménez, 2015; Granados-Chavarría, 2016; Gómez-Arredondo et al., 2016; Munguía et al., 2016a,b; Rodríguez-Cardozo, 2016; Rodríguez-Pérez and Singh, 2016; Suárez et al., 2016; Vallée and Douet, 2016; Singh et al., 2017; Yela-Portilla, 2018; Chávez-Hernández, 2019; Domínguez-Reyes et al., 2019; Quintanar et al., 2019; Méndez-Alarcón, 2020; Singh et al., 2020a,b; Mendoza-Zúñiga, 2021; Néquiz-Guillén, 2021; Núñez-Cornú et al., 2021; Sánchez-Lopez, 2021; Corona-Fernández and Santoyo, 2022; Huesca-Pérez et al., 2022).

On the other hand, focal mechanisms of geothermal events include 151 events reported in the literature (Albores et al., 1980; Fabriol and Munguía, 1997; González et al., 2001; Rebollar et al., 2003; Antayhua-Vera, 2007; Suárez-Vidal et al., 2007; Romero-Domínguez, 2013; Pérez, 2017; Oregel-

Morales, 2019; GEMex project, 2020). Finally, the volcanic earthquakes part consists of 54 focal mechanisms (Núñez-Cornú and Sánchez-Mora, 1998; Jimenez-Jimenez, 1999; Arámbula-Mendoza, 2007; Pinzón et al., 2017; Angulo-Carrillo, 2018; Núñez et al., 2022). Focal mechanisms reported in this catalog were derived with the following techniques: 1) regional and teleseismic moment tensor inversion (4747 fault plane solutions with $1.4 < M < 8.2$), 2) waveform analysis (208 fault plane solutions with $1.4 < M < 8.1$), and 3) first-motion wave polarities of single or composite mechanisms (2584 with $0.4 < M < 8.2$, and 125 with $-0.9 < M < 5.7$, fault plane solutions, respectively).

2.2 Methods

After carefully searching focal mechanism solutions in the literature, we classify all the focal mechanisms in our catalog. For this purpose, we use the FMC's computer program (from Focal Mechanisms Classification) (Álvarez-Gómez, 2019). The software uses the Kaverina-type classification diagrams (Kaverina et al., 1996) to verify the rupture type of focal mechanism data. The Kaverina-type ternary diagrams classify earthquakes into seven rupture types based on the plunges of the *P*, *B*, and *T* principal axes: 1) normal (N), 2) normal – strike-slip (N-SS), 3) strike-slip – normal (SS-N), 4) strike-slip (SS), 5) strike-slip – reverse (SS-R), 6) reverse – strike-slip (R-SS), and 7) reverse (R) (lower panel in Fig. 1). Subsequently, we calculate the missing information of the fault/auxiliary planes, and principal axes. At this stage, we use the code library “cmt” of seizmo software (Euler, 2014). Seizmo is a collection of different Matlab libraries to perform different tasks in seismology. In particular, we use the library called "cmt" which deals with obtaining auxiliary planes, calculating fault angles, and converting focal mechanisms, principal axes, and moment tensors. This library is made up of several functions, some of which we use and briefly describe below. We use the function “auxplane.m” to calculate the auxiliary focal plane. The function “sdr2tpb.m” is used to determine the principal axes of a focal mechanism. In some cases, we have to convert the moment tensor and principal axes to strike, dip, and rake angles. For that purpose, we use the function “tpb2sdr.m”. Transformations of moment tensors to strike-dip-rake are performed with the function “mt2sdr.m”. In cases where only the strike and dip of the fault and auxiliary planes were reported, the rake angles are calculated with the function “GetRake” of the RFOC software (Lees, 2018). The package RFOC is written in *R* language and deals with graphics for statistics on a sphere, earthquake focal mechanisms, radiation patterns, and ternary plots.

Our database merges focal mechanism solutions from different studies that used different methodologies, each with a different uncertainty level. To address this variability in data and methods, we rank the quality and reliability of the focal mechanisms in our catalog using the following criteria. We assign a quality factor based on data availability and the calculation process. For data availability, we consider the number of observations, quality of the records (e.g., digitized seismograms, type of instrument), and their spatial distribution (hypocentral distance and station coverage). In the case of the calculation process, we consider the uniformity of the method throughout the reported study, the methodology's description, and the method's calibration (selection of input parameters for the method chosen to calculate focal mechanisms or moment tensors). A good calibration considers a correct selection of the medium's properties, especially the velocity model used to calculate travel times or synthetic seismograms. Due to the lack of uncertainty estimates reported in several studies, we do not consider them for assigning a quality factor in most fault plane solutions. The quality of the moment tensor solutions is assigned based on the overall variance reduction (VR). The VR describes the goodness of fit between observed and synthetic waveforms of the moment tensor inversion. We only considered VR to assign a quality factor when it was available. Franco et al. (2020) studied seismic moment tensors in Mexico, and they established that a value of $VR \geq 50$ % is a reasonable threshold for reliable focal mechanism solutions.

We classify the focal mechanism data into three categories: A, B, and C. A represents good/reliable data, B represents regular, and C represents poor/questionable data. Category A has one or more of the following situations: an adequate velocity structure, a VR of > 70 %, an adequate number of observations, a good spatial distribution of observations, a uniform methodology (avoiding the use of several methods to obtain parameters and mix the results), a good description of the method (advantages and disadvantages of the technique used) and data processing, and modern seismic instrumentation. Category B has one or more of the following situations: an adequate velocity model, a VR range of 50 % < VR< 70 %, few observations, a regular spatial distribution of observations, a uniform methodology, and a good description of the method and data processing. Category C has one or more of the following situations: a global/mean velocity model, a VR of < 50 %, few observations, poor spatial distribution of observations, nonuniform methodology, a poor description of the method and data processing, and analog instrumentation. Here, the term adequate velocity model refers to the model being specific to the region where the earthquakes are generated. Since, in many cases, average models are used that cover vast regions of the territory of Mexico. The quality criterium presented here may help the user decide if the selected focal mechanisms are suitable for their analysis or study. For each focal mechanism solution, we show all the magnitudes reported. An event can have a different type of magnitude. Given all the different magnitude scales, compiling a unified magnitude scale is a demanding task requiring further detailed analysis outside this study's scope. In addition, the main objective of this study is the focal mechanisms per se.

We provide our catalog in ASCII and Excel files entitled “Focal_mechanisms_Mexico_1928-2022”. In this file, we provide the following information: 1) the number of the event, 2) the number of solutions named as S-1, S-2, and S-*n*, where *n* is the number of a solution, 3) date of the event, 4) origin time, 5) longitude of the epicenter, 6) latitude of the epicenter, 7) hypocentral depth, 8) magnitude for each of the solutions, 9) rupture type (N, N-SS, SS-N, SS, SS-R, R-SS, and R) , 10) strike angle 1, 11) dip angle 1, 12) rake angle 1, 13) strike angle 2, 14) dip angle 2, 15) rake angle 2, 16) plunge of the *T*-axis, 17) azimuth of the *T*-axis, 18) plunge of the *P*-axis, 19) azimuth of the *P*-axis, 20) plunge of the *B*-axis, 21) azimuth of the *B*-axis, 22) tectonic environment (tectonic, geothermal zone or volcanic), 23) observations of the event (here we reported the type of magnitude for each of the solutions, M_S, m_b, M_W, M_L, and M_c), 24) method used to determine the focal mechanism (first arrivals, composite solution, waveform analysis, moment tensor), 25) variance reduction when the information was available, 26) quality of the event, and 27) bibliographical references or seismological agency. When the information is missing (the origin time, the seismic magnitude, or the hypocentral depth), the database cell is highlighted in red, and a question mark is also shown in the cell.

3 Results

The information in this catalog is presented in an easy-to-understand manner as an aid to the user. The classification of the focal mechanisms in our catalog yielded 1750 events with normal-faulting (Fig. 2). Earthquakes with N-SS faulting include 691 events (Fig. 3). On the other hand, reverse-faulting forms a group of 2248 earthquakes (Fig. 4). R-SS faulting consists of 351 events (Fig. 5). Pure strike-slip rupture is made up of 1320 seismic events (Fig. 6). SS-N faulting comprises a group of 792 earthquakes (Fig. 7). SS-R faulting is made up of 512 seismic events (Fig. 8). The earthquake magnitude distribution for all types of faulting exhibits bimodal distributions (Figs. 2 to 8). Several factors can explain this. On the one side, the earthquake detection capability of permanent seismic networks has improved with new developments and densification of seismometers. On the other hand, it is also due to the use of temporary networks used to study aftershock sequences and seismic swarms.

4 Discussion

In Figs. 9 to 15, we show the orientation of the pressure and tension axes. Some conspicuous differences can already be distinguished among the different tectonic regimes. We provide some statistics on P and T axes for each type (Table 1) which may serve as a first step to a more detailed analysis since this is not the aim of this work. We interpret the large deviations from the main trends in data presented in Table 1 as arising from the mixture of tectonic regimes involved in the average; these should decrease when differentiating among such regimes. Nevertheless, the azimuths of the P and T axes primarily reflect the expected conditions of subduction for events of the R type which dominate this type of events, as well as the trends of transform faults in the case of SS type. N-type events comprise a mixture of tectonic regimes which precludes identifying a particular regime as dominating the whole data set. Even though a detailed tectonic analysis is out of the scope of this work, we believe that the data presented here will make such a task more accessible and provide a basis for systematic comparisons.

5 Conclusions

We collect and revise focal mechanism solutions previously reported by different agencies and studies from published sources to compile a catalog of focal mechanisms for Mexico. Our catalog consists of 7664 solutions for 5701 local and regional events. From these, 1750 events correspond to normal faulting, 691 events to N-SS, 2248 to pure-reverse, 351 to R-SS, 1320 to pure strike-slip, 792 to SS-N, and 512 to SS-R faulting. These account for 32% of the solutions corresponding to normal in general, 34% to reverse, and 34% for the dominantly strike-slip type. Besides including all information about the source of the data, we also ranked the quality of the focal mechanism data into three categories: A, B, and C. A represents good/reliable data, B represents regular, and C represents poor/questionable data according to a robust criterion. Moment tensor inversion involves many assumptions and constraints that make evaluating confidence in fault planes difficult. For this reason, we present all the focal mechanism solutions available for one event. In this way, the users can consider the variability of the focal mechanisms in their analysis.

6 Data availability

Some focal mechanisms described in this article are available at the following data sources: 1) Global Centroid Moment Tensor (Global CMT) via https://www.globalcmt.org (Dziewonski et al, 1981; Ekström et al., 2012), 2) Mexican Global Centroid Moment Tensor via http://132.248.6.13/cmt, 3) GEOFON Global Seismic Network via https://geofon.gfz-potsdam.de/old/eqinfo/list.php?mode=mt, 4) International Seismic Centre (ISC) bulletin (https://doi.org/10.31905/D808B830, International Seismological Centre, 2022), 5) U.S. Geological Survey (USGS) via https://earthquake.usgs.gov, 6) Saint Louis University moment tensor catalog via http://www.eas.slu.edu/eqc/eqc_mt/MECH.NA, 7) SCARDEC Source Time Functions Database via http://scardec.projects.sismo.ipgp.fr (Vallée and Douet, 2016), and 8) Southern California Seismic Network (SCSN) earthquake catalogs via http://www.eas.slu.edu/eqc/eqc_mt/MECH.NA (California Institute of Technology and United States Geological Survey Pasadena, 1926). In all cases, last access: 17 September 2022. The focal mechanism catalog derived from this study is available in Rodríguez-Pérez and Zúñiga (2022, https://doi.org/10.6084/M9.FIGSHARE.21663668.V1).

7 Code availability

All figures were plotted by the Generic Mapping Tools software package (https://www.generic-mapping-tools.org; Wessel et al., 2013). Earthquake fault classification were performed with FMC software (https://github.com/Jose-Alvarez/FMC; Álvarez-Gómez, 2019). Conversions among fault planes, principal axes and/or moment tensors were performed with RFOC and seizmo cmt codes (https://github.com/cran/RFOC; Lees, 2018; and https://github.com/g2e/seizmo).

Author contributions.

QRP and FRZ designed the idea and discussed the results. QRP was responsible for the data collection and earthquake selection. The two authors contributed to the manuscript and approved the final version.

Competing interests.

The authors declare that they have no conflict of interest.

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Table 1. Mean and standard deviations for the principal stress axes trends for each type of mechanism.

Type	*T*-axis plunge	*T*-axis azimuth	*P*-axis plunge	*P*-axis azimuth
N	66.81°±13.35°	184.71°±91.23°	19.02°±13.43°	146.82°±106.75°
N-SS	55.18°±7.35°	190.58°±92.75°	12.06°±7.34°	177.73°±102.20°
R	20.35°±12.27°	184.40°±78.51°	66.67°±12.23°	109.95°±102.42°
R-SS	14.10°±8.32°	185.00°±104.45°	54.38°±7.92°	173.10°±100.26°
SS	8.19°±6.07°	216.95°±111.41°	7.29°±5.60°	181.58°±96.02°
SS-N	30.65°±6.74°	196.09°±108.33°	11.82°±7.58°	190.12°±99.39°
SS-R	13.90°±8.85°	184.44°±113.30°	30.01°±7.37°	172.57°±102.16°

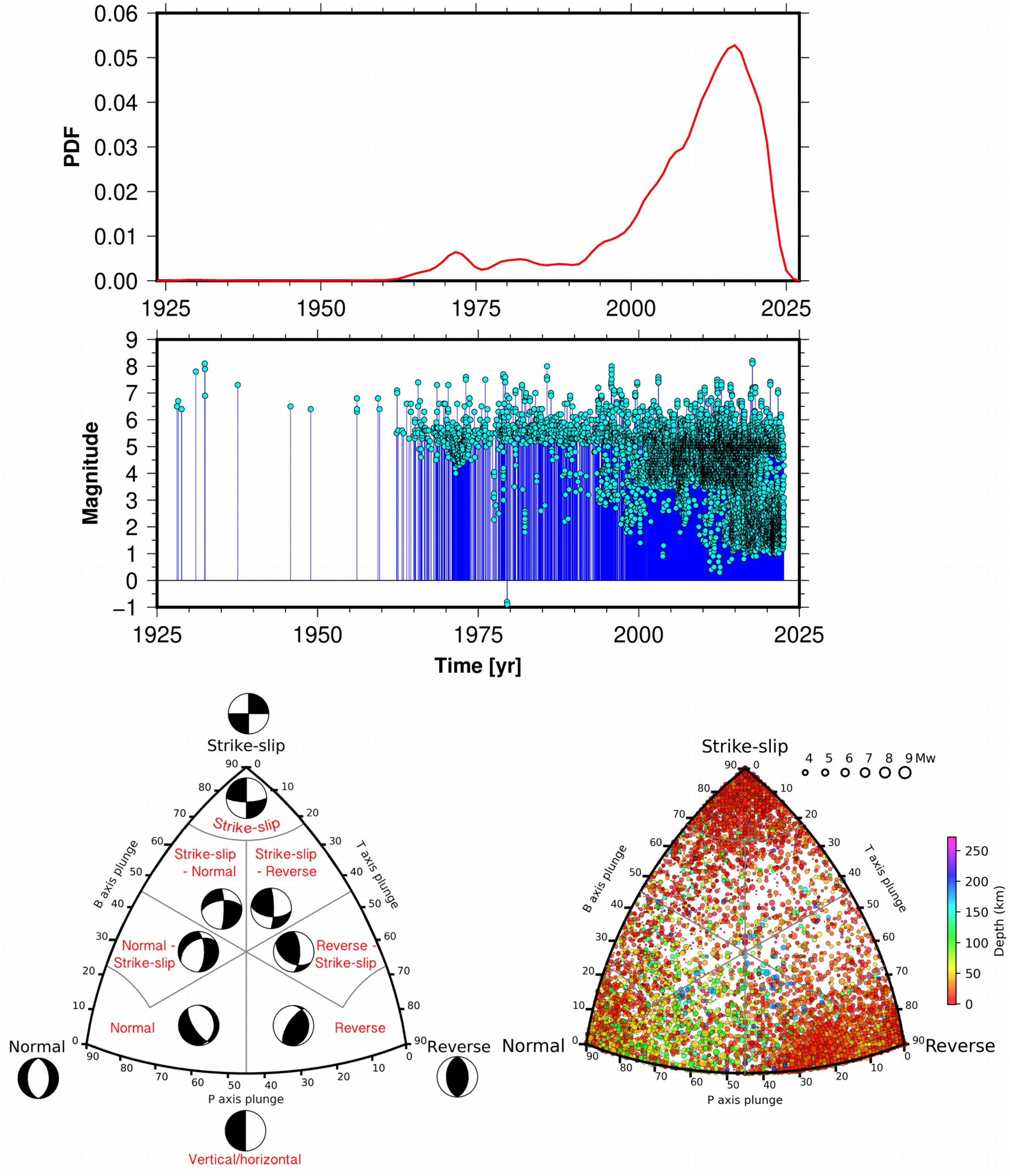

Figure 1. Probability density function and magnitude time series of seismic events with at least one focal mechanism reported in this catalog (upper panels). The Kaverina rupture type classification ternary diagram (lower left panel). Classification of focal mechanisms (lower right panel).

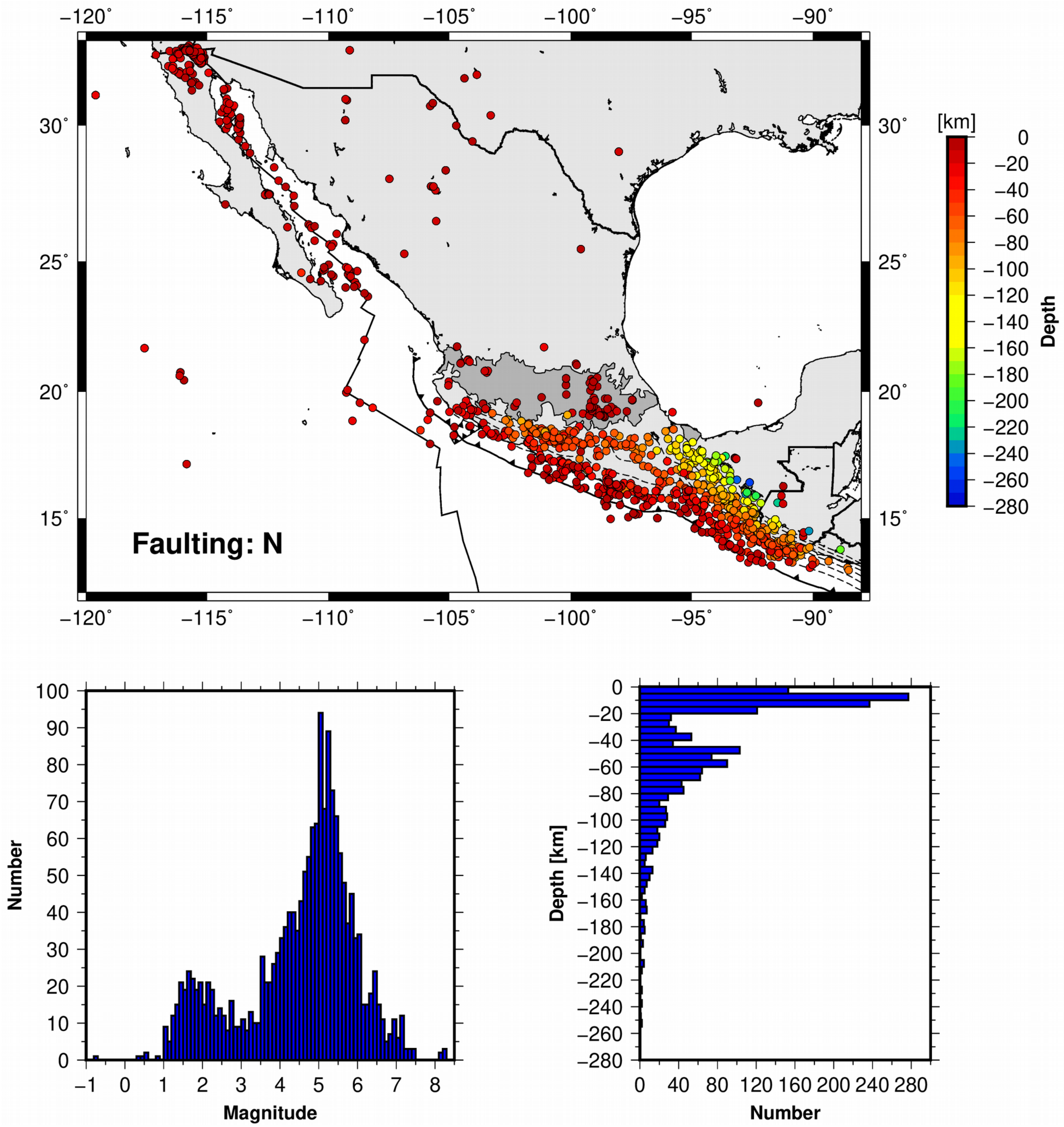

Figure 2. Hypocentral distribution of normal faulting earthquakes (N) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

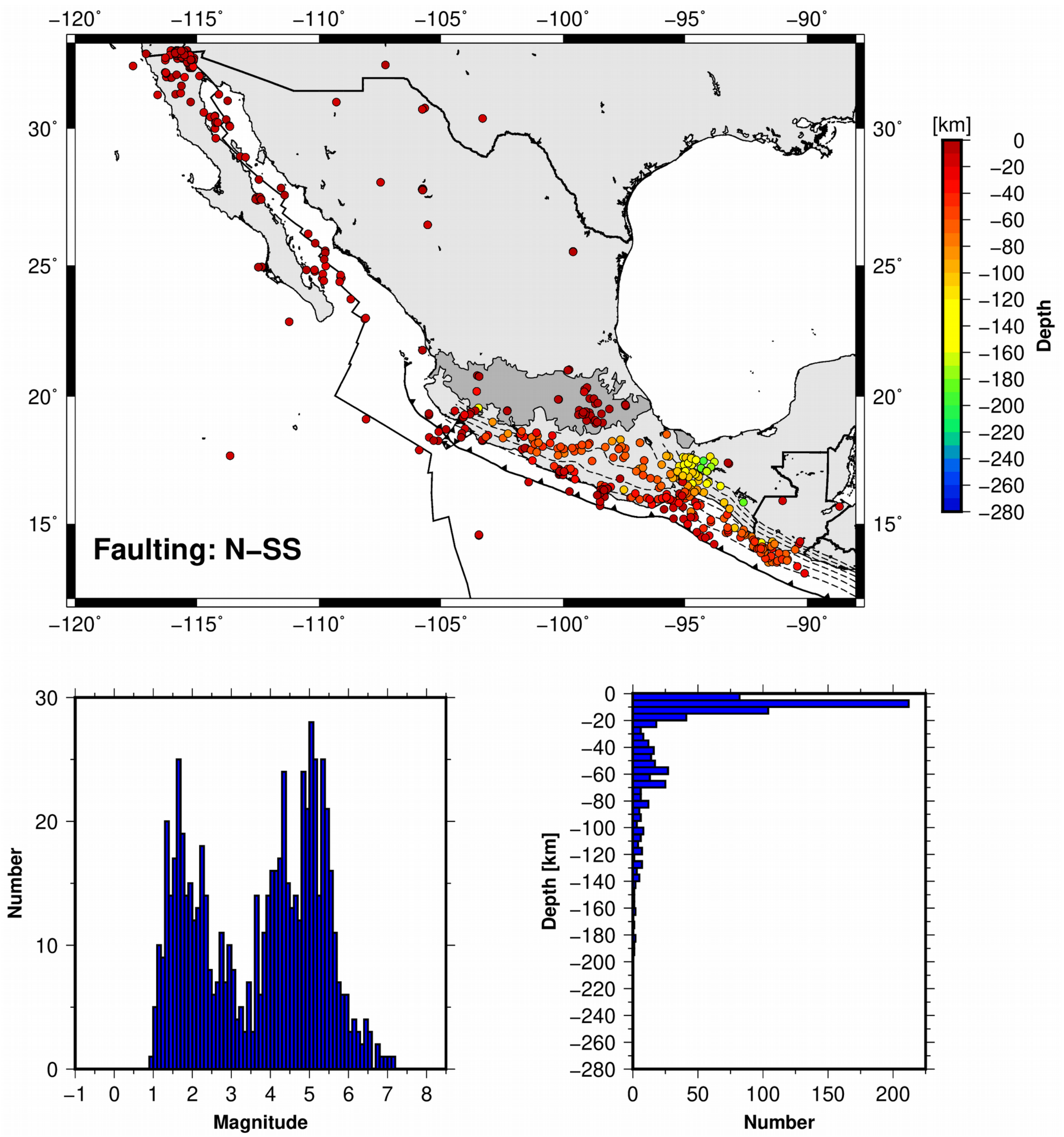

Figure 3. Hypocentral distribution of normal faulting with a strike-slip component earthquakes (N-SS) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

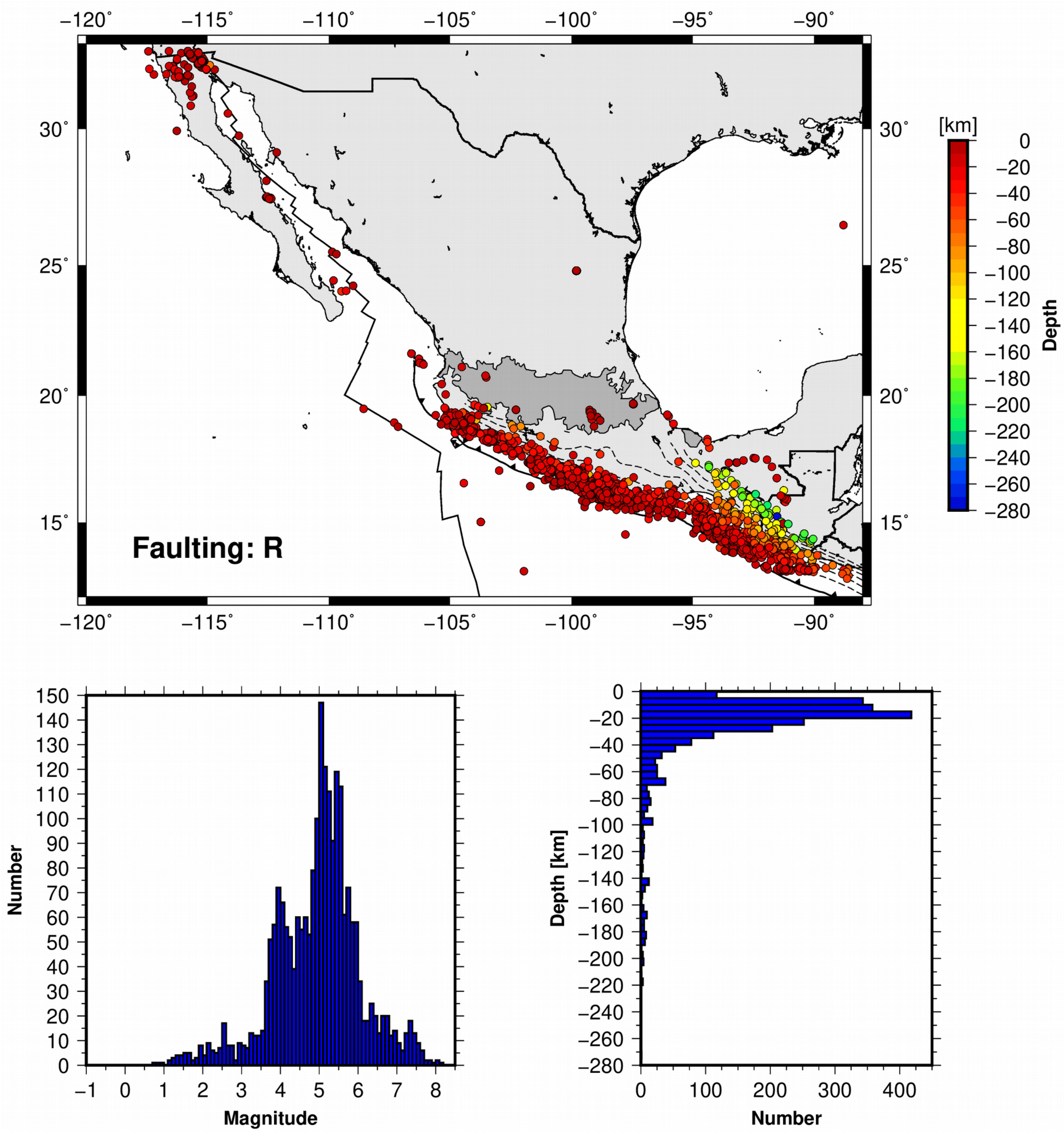

Figure 4. Hypocentral distribution of reverse faulting (R) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

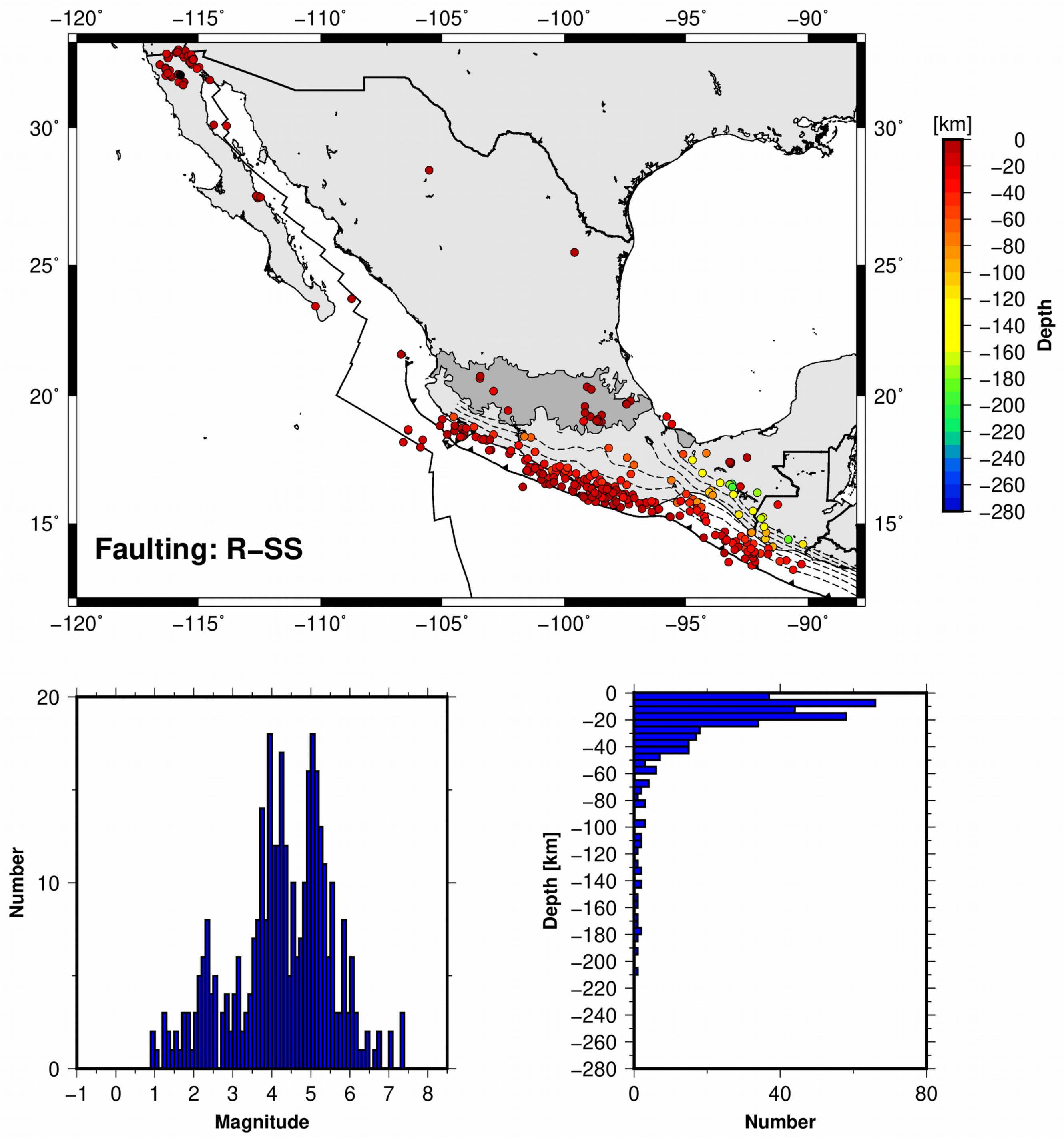

Figure 5. Hypocentral distribution of reverse faulting with a strike-slip component (R-SS) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

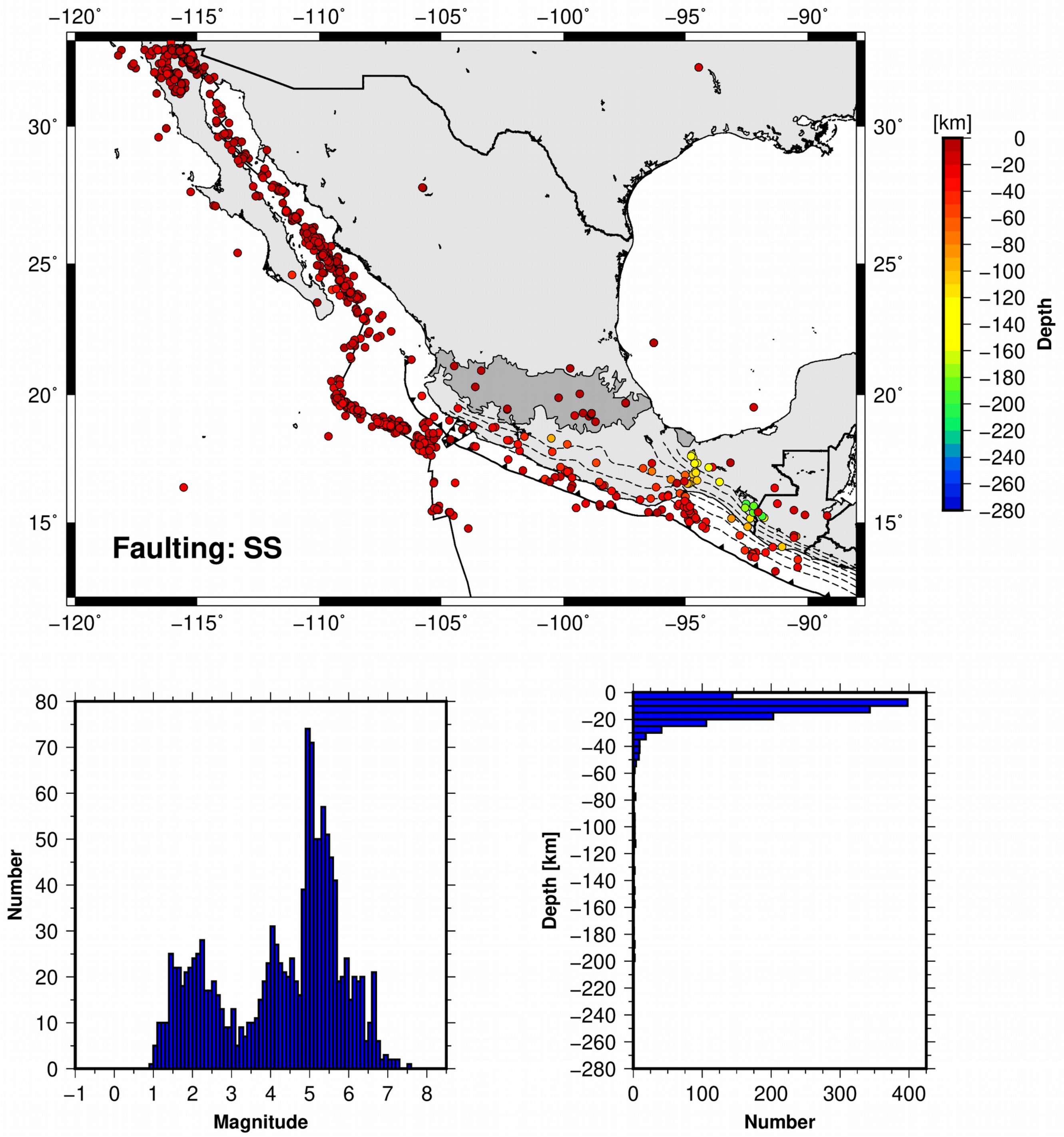

Figure 6. Hypocentral distribution of strike-slip faulting (SS) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

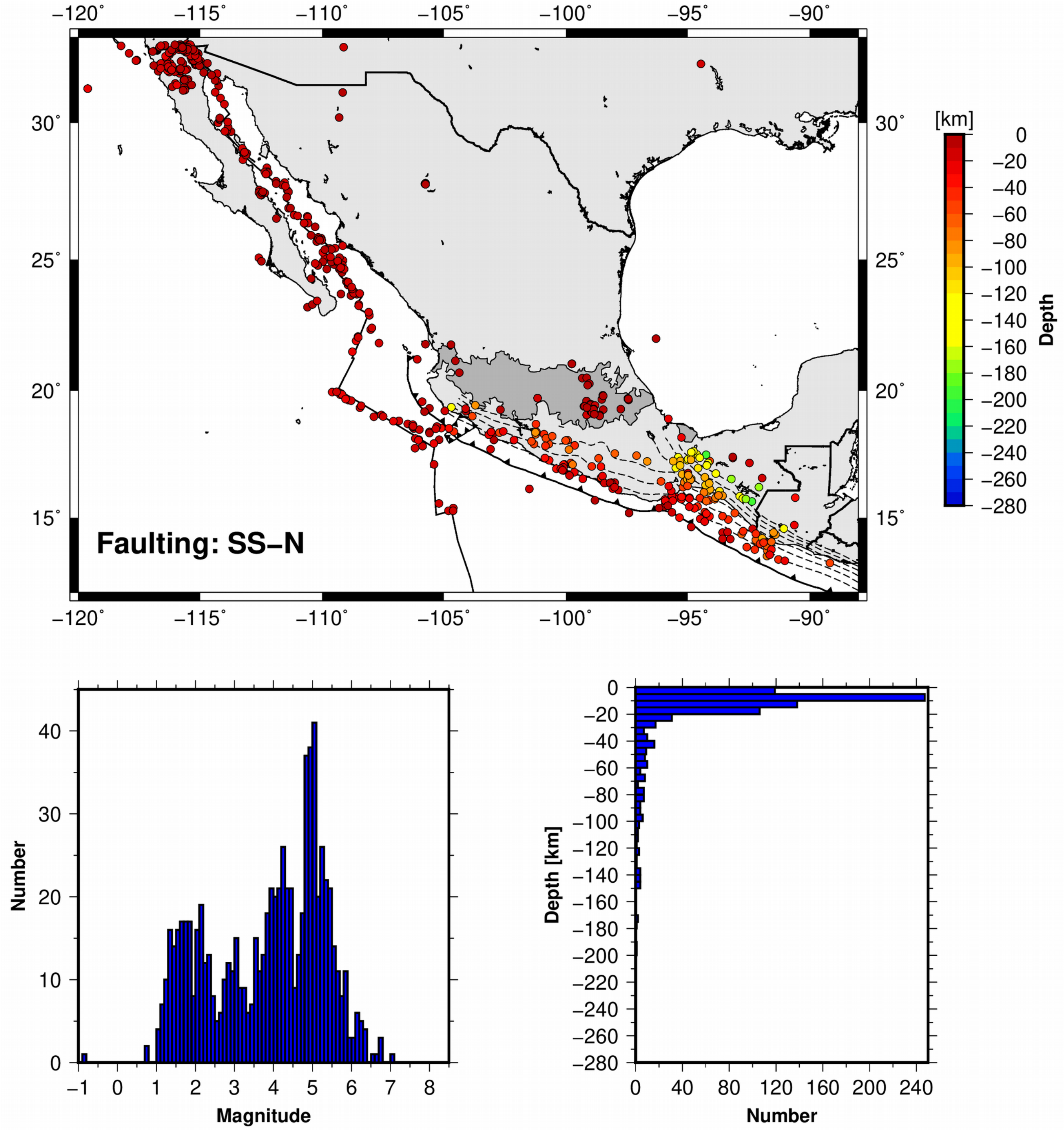

Figure 7. Hypocentral distribution of strike-slip faulting with a normal component (SS-N) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

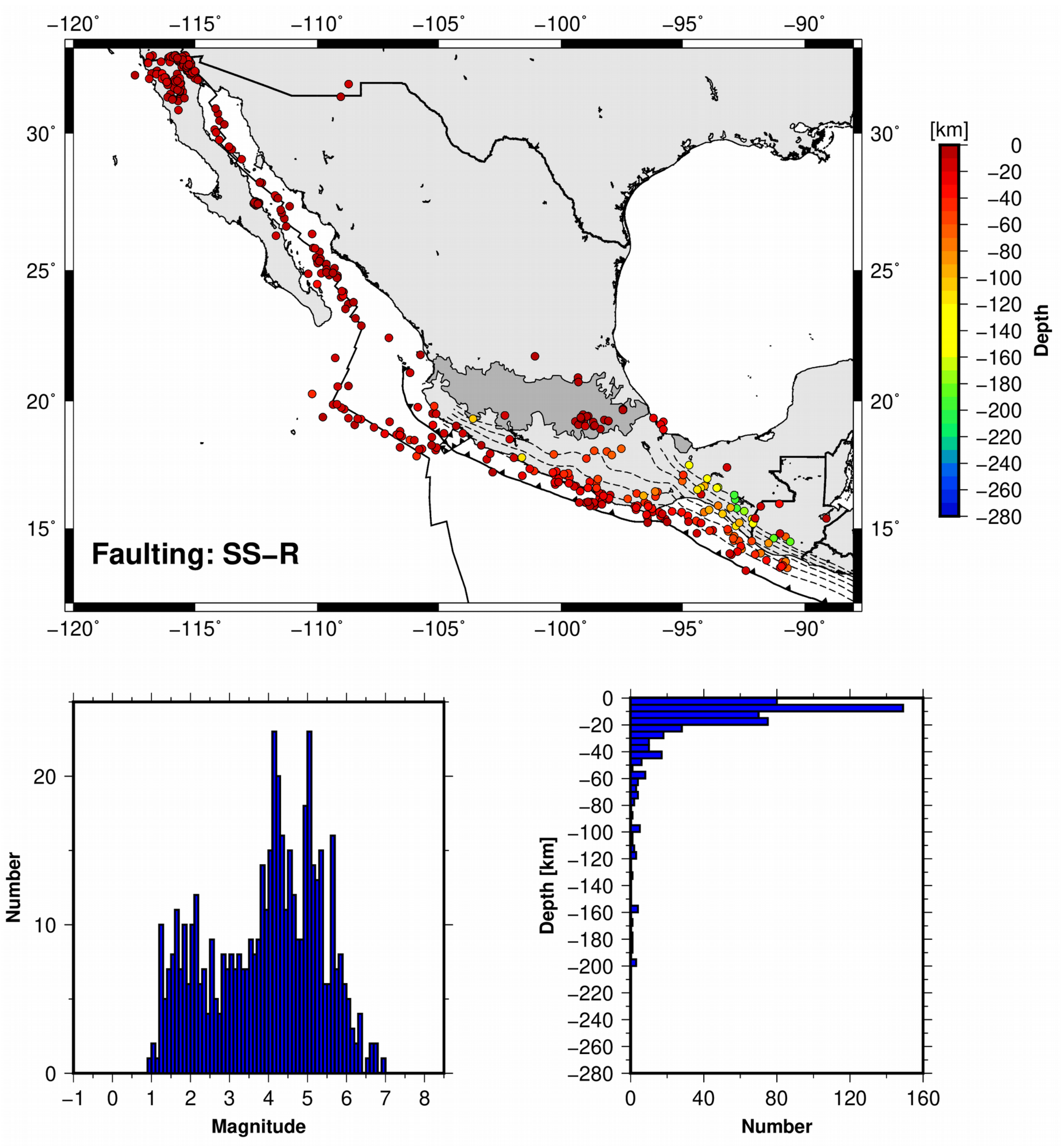

Figure 8. Hypocentral distribution of strike-slip faulting with a reverse component (SS-R) (upper panel). Lower panels show magnitude and hypocentral depth distributions.

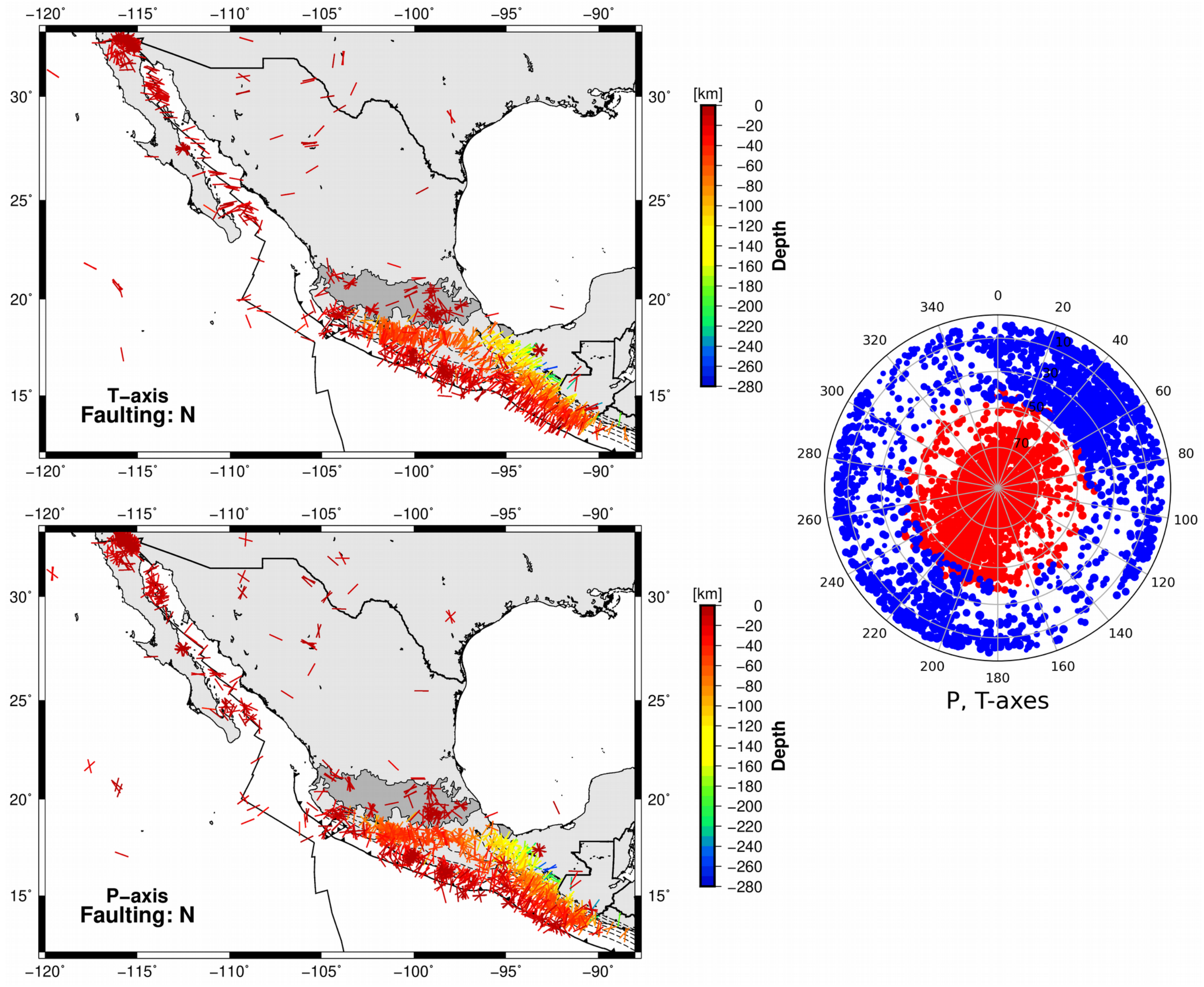

Figure 9. Spatial distribution of P- and T- axes for normal faulting earthquakes (N) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).

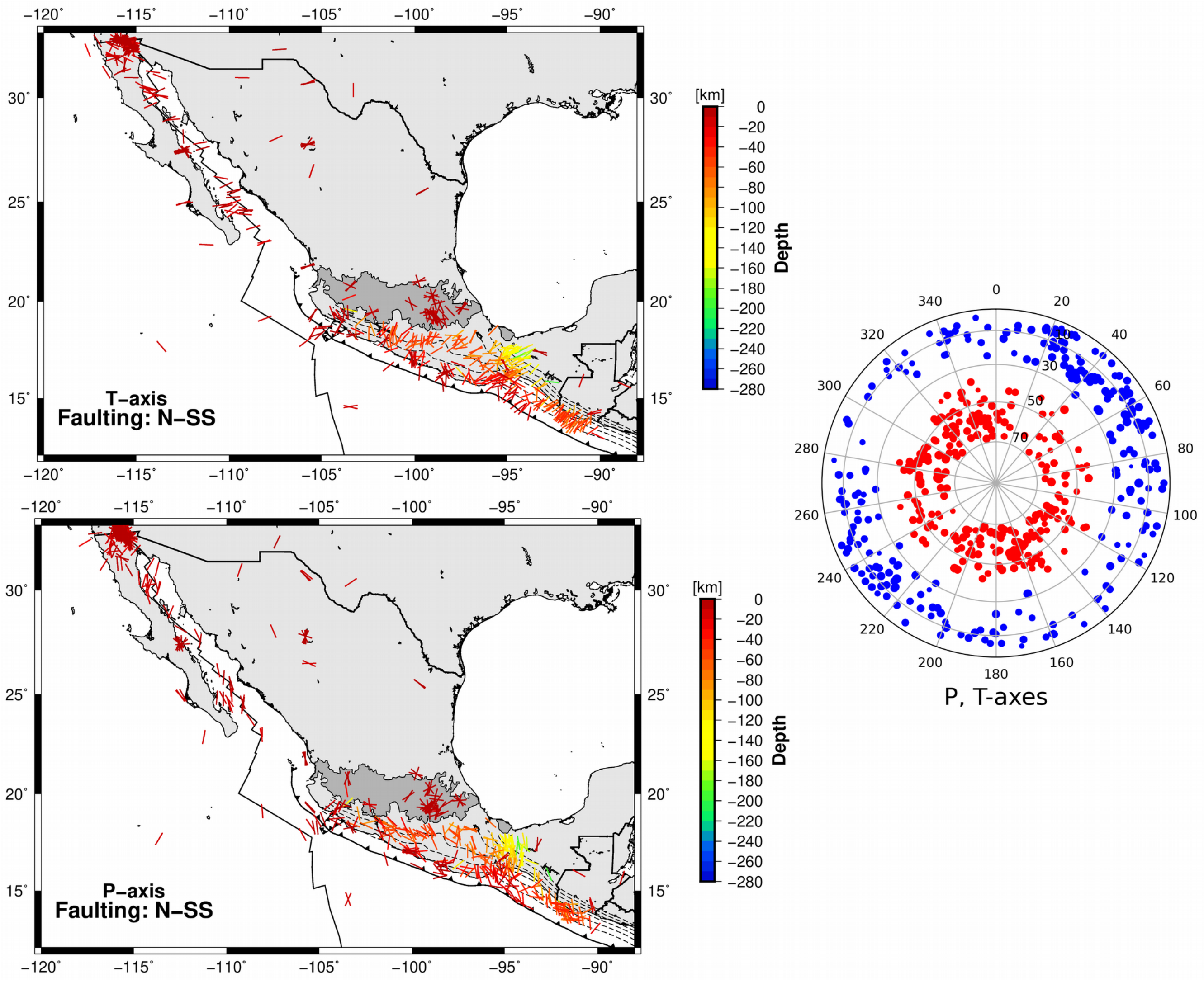

Figure 10. Spatial distribution of P- and T- axes for normal faulting with a strike-slip component earthquakes (N-SS) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).

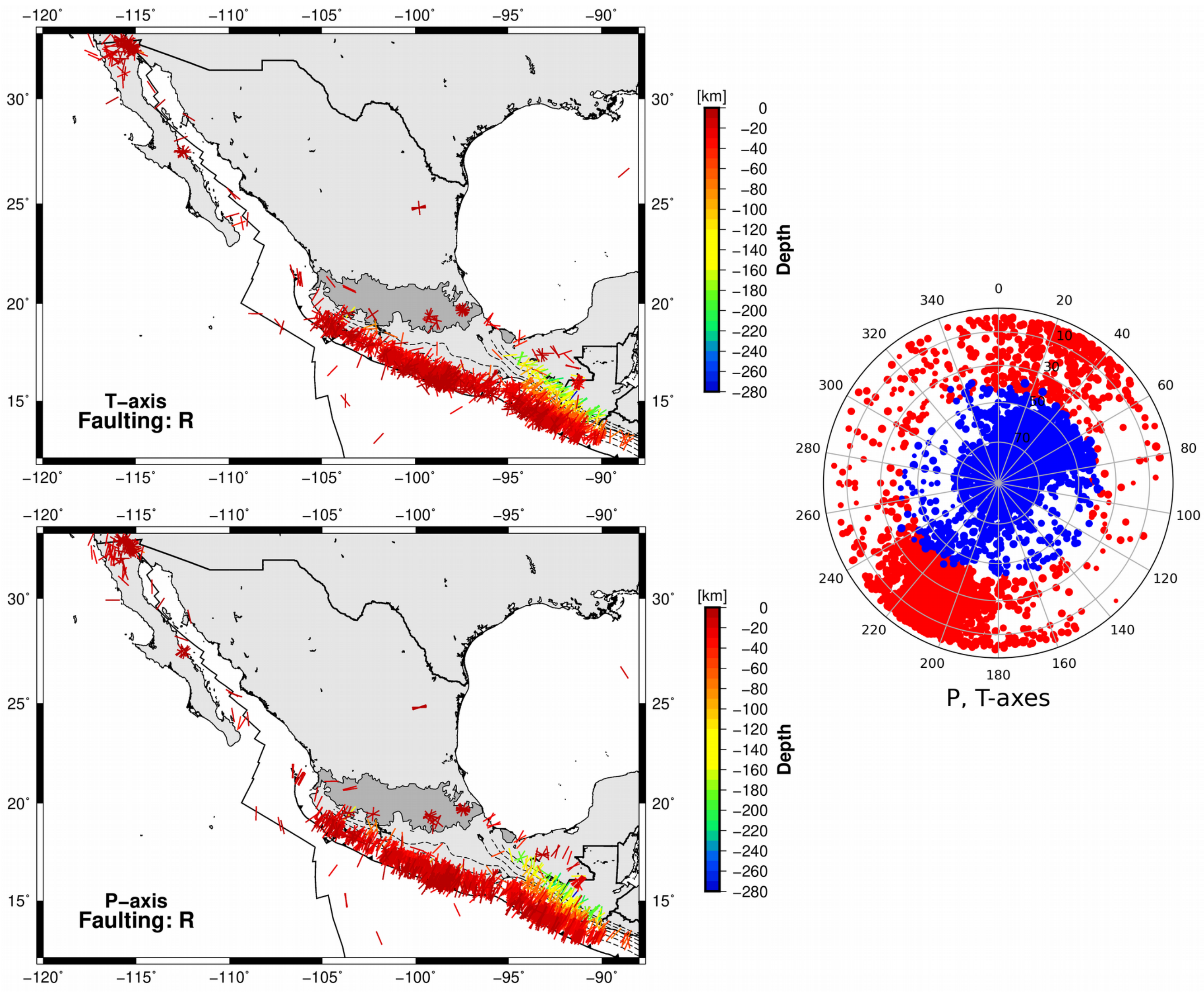

Figure 11. Spatial distribution of P- and T- axes for reverse faulting (R) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).

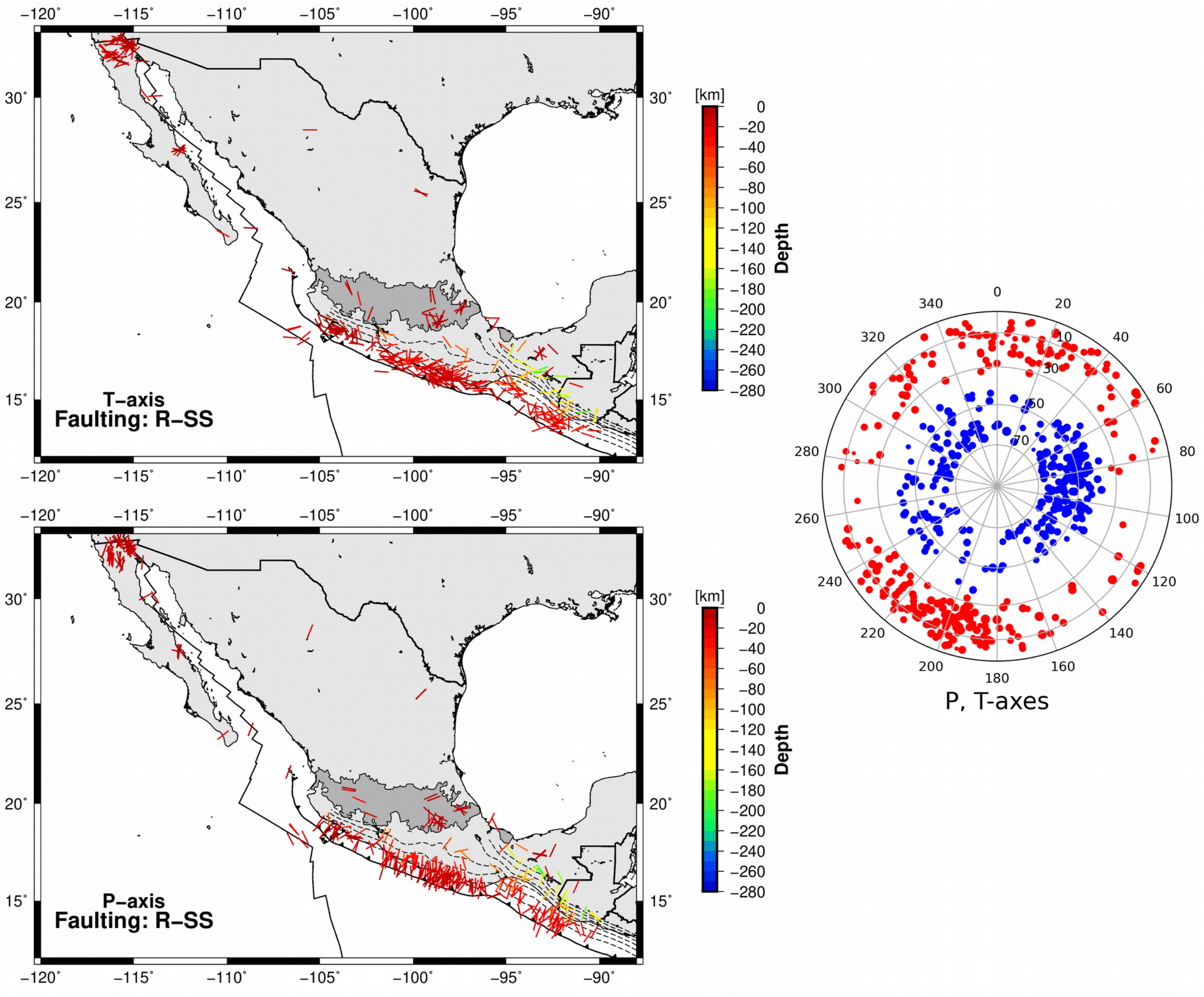

Figure 12. Spatial distribution of P- and T- axes for reverse faulting with a strike-slip component (R-SS) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).

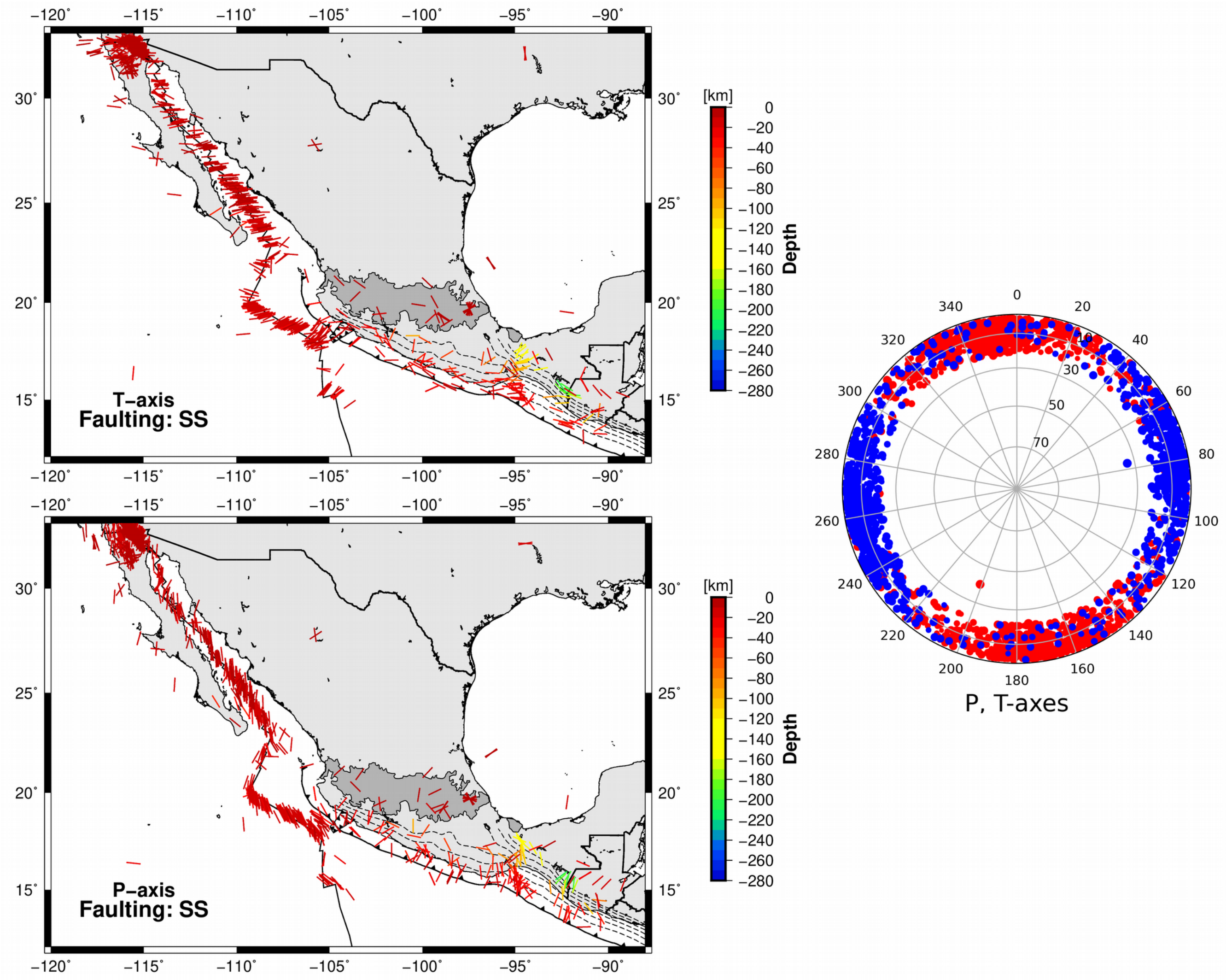

Figure 13. Spatial distribution of P- and T- axes for strike-slip faulting (SS) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).

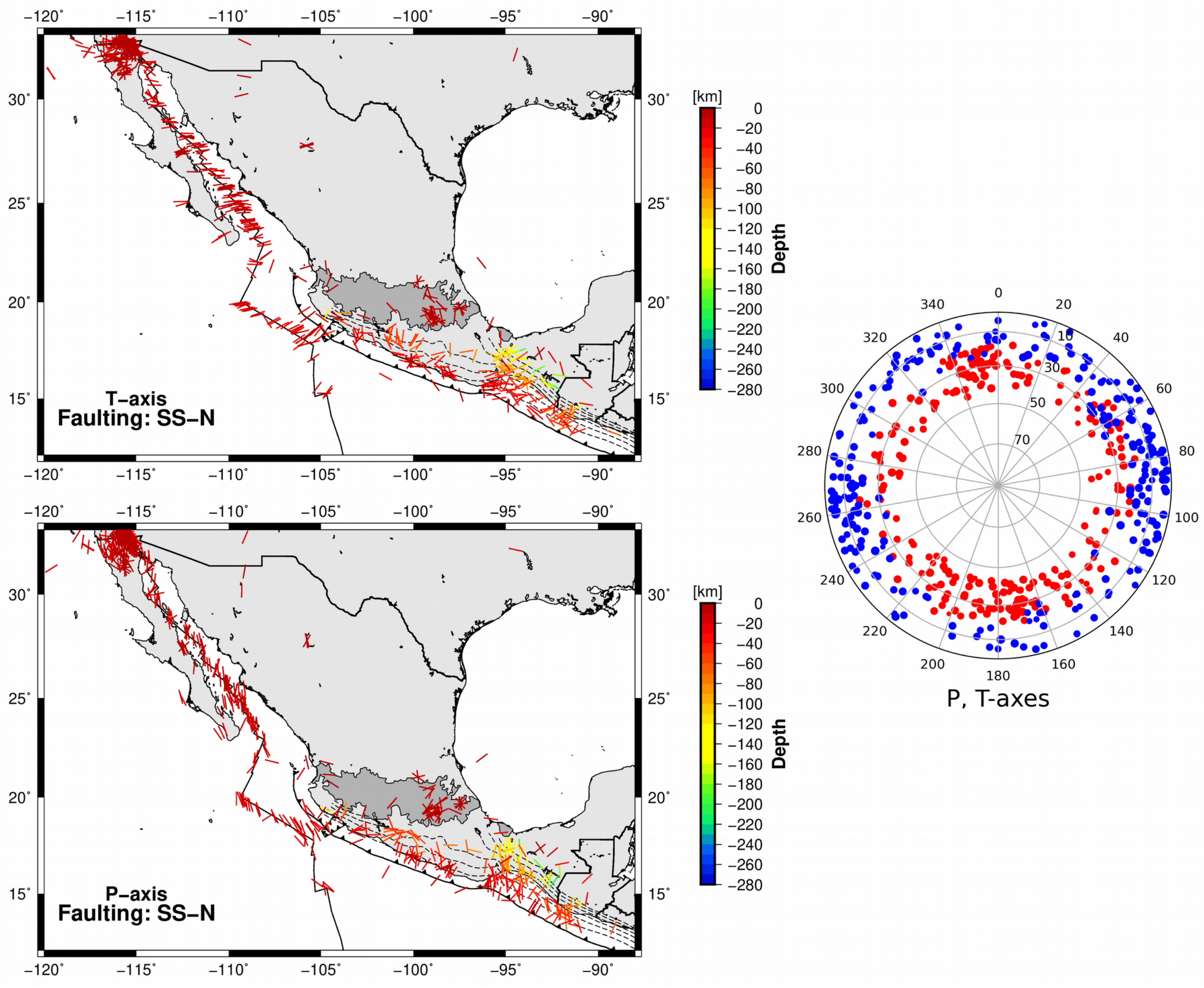

Figure 14. Spatial distribution of P- and T- axes for strike-slip faulting with a normal component (SS-N) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).

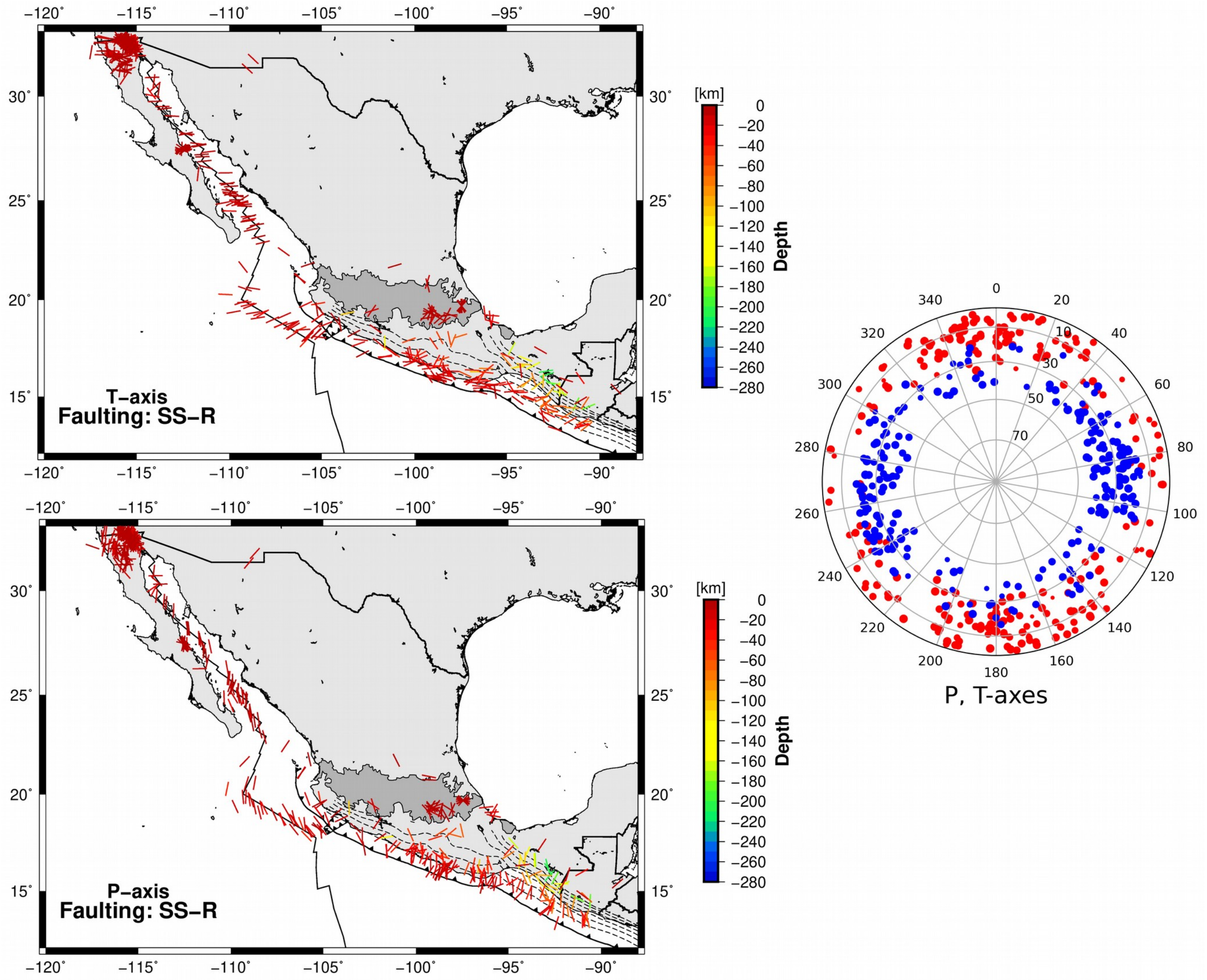

Figure 15. Spatial distribution of P- and T- axes for strike-slip faulting with a reverse component (SS-R) (lower and upper left panels, respectively). Distribution of P- and T- axes (red and blue colors, respectively) (right panel).