## Статии и абстракти на английски

на д-р Гергана Димитрова Георгиева
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# Доктор

**Georgieva, G., & Nikolova, S.** (2013). The Moho depth and crustal structure beneath Bulgaria obtained from receiver function analysis. *Comptes rendus de l'Académie bulgare des Sciences, 66*(5), 725–732. DOI: 10.7546/CR-2013-66-5-13101331-15.

*Abstract*
Receiver function technique is applied to evaluate the Moho depth and VP / VS ration on the territory of Bulgaria. The method was applied to eleven stations of the Bulgarian National Seismological Network (BNSN) equipped with broadband seismometers and the results are presented in this paper.
The results obtained show that the Moho depth varies between 30 and 50 km. The crust is shallower in northeast of Bulgaria and goes deeper in southwest direction. The crust is thicker in the Rhodopean massif, where it reaches more than 50 km. The VP / VS ratio in the study area varies between 1.60 and 1.90.
*Key words:* receiver function analysis, Moho structure, VP / VS

**Dimitrova, L., Georgieva, G., Raykova, R., Gourev, V., Aleksandrova, I., Raykova, P., Popova, M., & Protopopova, V.** (2015). Initial Stage of the Project for Research Seismicity of Livingston Island. *Proceedings of the 8th Congress of the Balkan Geophysical Society*, 1–5. https://doi.org/10.3997/2214-4609.201414226

*Abstract*
The paper presents the assessment of the hardware and software equipment as the initial stage of the implementation of the project DFNI I02/11 "Creating an information base for exploration of seismicity and Earth structure of Livingston Island and surroundings by complex research in the Bulgarian Antarctic Base area". Broad Band seismometer Guralp CMG40T with flat frequency response from 30s to 50Hz and digitizer Reftek DAS130 were installed in the yard of Vitosha Geophysics Observatory (1400m). The equipment was working in extreme weather conditions during February, 2015. The distribution of Power Spectral Density of the ambient noise was estimated and the performance of the tested equipment and the seismological equipment working in the Observatory was compared. Software developed on the base of Golitzynin method and the receiver function techniques were applied over several earthquakes. The assessment of the efficiency of the hardware equipment and the methods applied proved that they are suitable to explore the seismicity of Livingston Island and surroundings.

# Главен асистент

Дисертационен труд за присъждане на образователната и научна степен „доктор"

# Доцент

**Georgieva, G.** (2015). Mantle Transition Zone beneath Bulgaria and Surrounding Countries. *Comptes rendus de l'Académie bulgare des Sciences, 68*(6), 755–760.

*Abstract*
Receiver function technique is used to study upper mantle structure and the transition zone in the mantle beneath Bulgaria. It is applied to the data from 11 stations of the National Digital Seismological Network equipped with broad band seismometers. The main discontinuities in the upper mantle are well observed beneath the territory of Bulgaria. These are lithosphere-asthenosphere discontinuity, which has a depth between 190-220 km, and discontinuities at c. 410 and 660 km. In Northern Bulgaria and beneath Sofia valley, these two discontinuities have different depths compared to the one in iasp91 velocity model.
*Key words:* mantle structure, mantle transition zone, upper mantle, receiver function analysis

**Georgieva, G.** (2015). Crustal and upper mantle structure in the southern part of the Moesian Platform obtained by data from seismic stations MPE, PVL and SZH. *Bulgarian Chemical Communications, 47*(Special Issue B), 323–330.

*Abstract*
Receiver function technique is used to study the crustal and upper mantle structure beneath Bulgaria. It is applied to the data from National Digital Seismological Network. The results for three seismic stations, situated in the southern part of Moesian platform, are reported. These stations, Malopestene (MPE), Pavlikeni (PVL) and Strazhitsa (SZH), are equipped with broad-band seismometers and RefTech 130 digitizers. The crustal structure beneath the seismic stations is very complex and the Moho discontinuity can't be tracked in all azimuths around the stations. The shallow Earth's crust discontinuities are obtained close to the three seismic stations. The most complex crustal structure is observed beneath the seismic station MPE. The main discontinuities in the upper mantle are well observed beneath the territory of Bulgaria. These are asthenosphere-mantle discontinuity, which has a depth between 190–220 km, and discontinuities at 410 and 660 km. In North of Bulgaria these two discontinuities have different depths than in iasp91 velocity model.

**Kampfová Exnerová, H., Dimitrova, L., Nagel, T., Dimova, L., Schiffer, C., Afzali, J., Dimitrov, D., Georgieva, G., Jedlička, P., & Kolínský, P.** (2025). AdriaArray experiment on the territory of Bulgaria. *Annals of Geophysics, 68*(5), Special Issue. https://doi.org/10.4401/ag-9295

*Abstract*
We describe stations of the AdriaArray Seismic Network deployed on the territory of Bulgaria. The network consists of 50 stations, 25 of which are permanent stations of the Bulgarian National Seismic Network NOTSSI. Another 25 temporarily deployed stations belong to MOBNET (Institute of Geophysics) and DanSeis (Aarhus University) pools. The temporary stations of MOBNET began their operation in June 2022, and the DanSeis pool's temporary stations in August and September 2022. For each of the stations, we document the site geology, station location, instrumental equipment, as well as data transmission, preprocessing and availability, which exceeds 95% at some stations. Noise at the stations stays between the limits of the New Low and New High Noise models. As an example of planned data exploiting, we present the P-to-S receiver functions for station BG11A in the Strandzha unit (southeast of Bulgaria) and respective Moho depth estimates from the P delay times, H-$\kappa$ stacking and from the 1D vS velocity-depth modeling at the station site.

**Vinnik, L. P., Georgieva, G., Oreshin, S., Makeyeva, L., Dragomirov, D., Buchakchiev, V., & Dimitrova, L.** (2021). Deep structure and dynamics of the central Balkan Peninsula from seismic data. *Physics of the Earth and Planetary Interiors / Физика Земли*, (6), 36–51. https://doi.org/10.31857/S0002333721060120

*Abstract*
Analysis of P- and S-receiver functions for 19 seismic stations on the Balkan Peninsula has been performed. Half of the stations are in Bulgaria. The crustal thickness varies from 28–30 to 50 km. The ratio of longitudinal and shear wave velocities in the upper crust reaches 2.0 in some places. In the southwest of the study area, the 410-km seismic boundary is uplifted by 10 km relative to nominal depth. The elevation may be caused by hydration and/or cooling of the mantle transition zone under the influence of the Hellenic subduction zone. A low S-wave velocity layer related to the 410-km boundary may be located atop this boundary. In the northwestern part of the study area this layer is present in spite of the absence of the 410-km boundary. A similar paradox has been previously noted in central Anatolia. Indications of a low-velocity layer are present at a depth exceeding 410 km. The simultaneous inversion of the receiver functions of the two types (P and S) and the Rayleigh wave phase velocities reveals a large (7–9%) decrease in the S-wave velocity in the upper mantle of southern Bulgaria and northern Greece. The thickness of the low-velocity layer (asthenosphere) is about 50 km. The lithosphere-asthenosphere boundary (LAB) is at depths of 40 to 60 km. In terms of tectonics, this zone is characterized as the South Balkan extension system. To the north of 43° N, the S-wave velocity in the upper mantle is usually at least 4.4 km/s and the LAB is not detected or is detected at a depth of over 80 km. The SKS analysis of azimuthal anisotropy reveals lateral zoning in the upper mantle that is correlated to velocity zoning. Probably, the mechanically weak low-velocity mantle of the South Balkan system is easily deformed, and the azimuth of the fast direction of anisotropy (20°) indicates the direction of extension. At the northern stations, the fast direction (about –30°) may be a reflection of an older process.

**Dimitrova, L., Georgieva, G., Raykova, R., Dimitrov, D., Gourev, V., Solakov, D., Georgiev, I., Raykova, P., Protopopova, V., & Aleksandrova, I.** (2017). Exploring seismicity of Livingston Island (Antarctica) and surroundings using records of Bulgarian Broadband Seismological Station LIVV during the austral summer 2015–2016. *Comptes rendus de l'Académie bulgare des Sciences, 70*(12), 1709–1718.

*Abstract*
Bulgarian broadband seismological station LIVV was installed on 19.12.2015 near the Bulgarian Antarctic Base "St. Kliment Ohridski" on Livingston Island. During the first deployment period in astral summer 2015–2016 more than 2000 events of different nature are recorded. About 200 of these events are identified as local, regional and teleseismic earthquakes. Two location methods are used to calculate the epicenters of the local and regional events. Golitsyn's method is applied on the three components records of earthquakes from LIVV station with clear P wave onset. DHypo software with different velocity models is used to calculate epicenters of earthquakes recorded by LIVV station and two Argentinean-Italian (AI) stations ESPZ and JUBA. Using both methods is a very appropriate technique to have stability of locations on Livingston Island and surroundings. The results obtained show comparatively high level of local seismicity in the eastern part of Livingston Island. Several earthquakes are located in the West from LIVV station. The magnitude estimates of the earthquakes are below 3 ($Mb_* < 3$).

**Buchakchiev, V., Dragomirov, D., Pandourska, E., Georgieva, G., & Dimitrova, L.** (2023). Seismicity in the Bransfield Strait, Antarctica, for the period 2020–2023 as recorded from LIVV seismic station. *Proceedings of the Bulgarian Academy of Sciences, 76*(12), 1851–1959. https://doi.org/10.7546/CRABS.2023.12.07

*Abstract*
The Bransfield Strait is situated between the Antarctic Peninsula and the South Shetland Archipelago. The seismic regime of the area is characterized by volcanic and tectonic activity, expressed in shallow, weak to moderate earthquakes. The global seismic networks locate the stronger earthquakes in this region. Weak events are recorded by standalone stations installed on the Antarctic continent and neighbouring islands, the number of which is not sufficient for good location. In the study, we present the processing of the seismic data for the period from January 2020 to January 2023 registered by Bulgarian Antarctic station LIVV and the produced results. The single-station localization method was applied and calculated, epicentres were compared with those listed in the European Mediterranean Seismological Centre catalogue. In the study period, the seismic pattern is dominated by swarm volcanic seismicity around Orca volcano, as well as three earthquake clusters of unknown origin in the vicinity of Livingston Island.

**Kolínský, P.; Meier, T.; Agius, M. R.; Bijedić, A.; Bokelmann, G.; Borleanu, F.; Brnović, D.; Cambaz, M. D.; Cammarano, F.; Čarman, M.; Cauzzi, C.; Chernih, D.; Csicsay, K.; Cvijić Amulić, S.; Czuba, W.; Diaz, J.; Dimitrova, L.; Dushi, E.; Evangelidis, C. P.; Faccenna, C.; Farfuliak, L.; Friederich, W.; Georgieva, G.; Horn, N.; Ivančić, I.; Jia, Y.; Kaviris, G.; Kovács, I. J.; Lebedev, S.; Le Breton, E.; Lukešová, R.; Mazur, S.; van der Meijde, M.; Molinari, I.; Mustafa, S.; Nagel, T.; Nielsen, S. B.; Obermann, A.; Papazachos, C.; Parolai, S.; Paul, A.; Piromallo, C.; Plicka, V.; Rietbrock, A.; Rondenay, S.; Rossi, G.; Rümpker, G.; Schiffer, C.; Schlömer, A.; Sigloch, K.; Silvennoinen, H.; Sokos, E.; Špaček, P.; Stipčević, J.; Tallarico, A.; Tiira, T.; Tilmann, F.; Valčić, D.; Wassermann, J.; Weszterg om, V.; Xhahysa, A.; Živčić, M.; Seismology Group**, the A. AdriaArray – a Passive Seismic Experiment to Study Structure, Geodynamics and Geohazards of the Adriatic Plate. *Ann. Geophys*. 2025, 68 (5), DM555. https://doi.org/10.4401/ag-9284.

*Abstract*
AdriaArray is a multinational initiative to cover the Adriatic Plate and its tectonically active surroundings – including units of Adriatic origin – with a dense regional array of seismic stations. AdriaArray provides data for imaging of the crustal and upper mantle structure and for the analysis of seismic activity and hazard. It will help to understand the causes of active tectonics and volcanic fields in the region. The network consists of 1092 permanent and 436 temporary broadband stations from 23 mobile pools. A homogeneous coverage of broadband stations is achieved in an area from the Massif Central in the west to the Carpathians in the east, from the Alps in the north to the Calabrian Arc and mainland Greece in the south. The backbone network (2022-2026) is complemented by locally densified broadband deployments in the western Carpathians, along the Dubrovnik fault and in the Vrancea region. Data recorded by AdriaArray stations is transmitted in real-time to 12 nodes of the European Integrated Data Archive (EIDA) where it is accessible as a single virtual network. Regular availability and quality checks ensure high data usability. AdriaArray, the largest passive seismic experiment in Europe to date, is based on the cooperation between local network operators, mobile pool providers, technicians, engineers, field teams, researchers, students, and organizations such as ORFEUS (Observatories and Research Facilities for European Seismology) and EPOS (European Plate Observing System). The AdriaArray Seismology Group, founded in 2022, encompasses 64 institutions from 30 countries with 451 participants. Initial

Collaborative Research Groups have been established to coordinate data analysis and scientific research. We present the evolution of the experiment and its objectives, describe its preparation and planning, and show maps of the AdriaArray Seismic Network, station properties and coverage. We further describe the data archiving and distribution, list the participating institutions, individuals and networks and discuss collaborative research topics.

**Georgieva, G.** (2015). Receiver functions obtained for seismic station Vitosha (VTS). *In Proceedings of the 7th National Conference on Geophysics with International Participation "Geophysics 2015"*. Bulgarian Geophysical Society.

*Abstract*
Receiver function technique was applied to the data from 11 seismic stations from National Digital Seismological Network (NDSN). The depth of Mohorovicic discontinuity was estimated beneath 10 of the seismic stations. Station Vitosha (VTS) is the only one, where the depth was not calculated. The reason for this is the very complex structure, obtained beneath this station

**Georgieva, G.** (2010). The Moho's structure in southwest of Bulgaria beneath the seismic stations VTS, KKB and MMB. *6th National Conference on Geophysics "20 Years Bulgarian Geophysical Society"*, Sofia, Bulgaria, 17 December 2010.

*Abstract*
The modernization of the Bulgarian Seismological Network completed in December 2005 enabled application of modern techniques of analysis of the velocity structure in Bulgaria. This study presents the first results from application of the receiver function technique to Bulgarian data. The Receiver functions were computed using scripts written on Seismic Handler program by Sodoudi and Yuan. The Western part of Bulgaria is characterized with mountains, river valleys and small fields between the mountains. Two stations of the Network Musomishte (MMB) and Krupnik (KKB) were chosen in south-west of Bulgaria and also station Vitosha (VTS) which is close to Sofia and known as the station with lowest noise. These sites are located in areas of complex tectonic structures manifesting high seismic activity during recent years. As starting models we used shear wave velocity models for the territory of Bulgaria, obtained in Raykova, 2004. For the study were used earthquakes in epicentral range 30 - 95o and with a magnitude between 5,5-5,7 and 7,5 and with clear P-onset. All earthquakes from the end of 2005 to the summer of 2010 were examined and after deleting of bad traces a good azimuthal covering was reached. From the seismic surveys and gravimetric measurement s the Moho depth for the territory of Bulgaria is determined between 30 km and 50 km. The crust is shallower in the north part of the country and thicker in the south-western part. The obtained results delineated a omplex structure of the Moho near station Vitosha and confirmed existence of a thicker crust near station Musomishte. Further detailization of the structure of the Moho boundary could be done after estimation of receiver functions for other stations of the network.

**Dimitrova, L., Georgieva, G., Trifonova, P., Oinakov, E., Protopopova, V., & Metodiev, M.** (2020). Seismic sources and Earth structure in the transition zone between Fore-Balkan unit and Moesian platform, NE Bulgaria. *Acta Geodaetica et Geophysica, 55*(2), 183–202.https://doi.org/10.1007/s40328-020-00288-3

*Abstract*
Investigations of hydraulically induced micro-seismicity are typically connected with magma injections, exploitation of geothermal fields and salt mines. Our study examines the seismicity and seismic sources in a peri-platform region with long salt production history. In addition, a very large site for extraction of aggregates and limestone is presented in the area. Increased seismicity in the region has been observed for

several decades as during the study period of the last 12 years, more than 1000 events with magnitude M<4.3 have been registered. To study the complex seismic sources concentrated in such small area spatial distribution of seismicity and fault plane solutions are analyzed together with available geological and geophysical data, in order to connect registered earthquakes swarms with geological structures. Results show that several faults are outlined from geological information and confirmed by interpretation of geophysical data. Very different focal mechanisms calculated for the 13 earthquakes in the near region of the salt production site cannot propose a dominant fault mechanism and confirm the complexity of the seismic sources in the area. Our results suppose that activation of some of these structures is more likely due to water injected in the salt dome as part of the production process, which changes the stress equilibrium in the Earth crust.

**Georgieva, G., Vinnik, L., Dragomirov, D., Buchakchiev, V., Oreshin, S., Makeyeva, L., & Dimitrova, L.** (2022). Crustal thickness and upper mantle structure in the region of Vitosha and Sredna Gora, Bulgaria. *Proceedings of the 3rd European Conference on Earthquake Engineering and Seismology*, Bucharest, Romania.

*Abstract*
The territory of Bulgaria is relatively small, but includes different tectonic units. This makes it very difficult to study the structure of the earth's crust and the upper mantle beneath its territory. The region of Vitosha Mountain and Sredna Gora Mountain is one of these small tectonic units developed as an island arc through the Late Cretaceous as a result of the extension. In our study, we focus on uppermantle structure and crustal thickness beneath Vitosha and Sredna Gora. The receiver function technique is applied to the data from broadband seismic stations situated on the territory of Bulgaria and in the neighboring countries. The estimated crustal thickness in the region is between 25 and 40 km and the Vp/Vs ratio is quite high and more than 1,8. An unusual wave field and low-velocity layer are obtained in the region. We assume the reason for their existence is the extension.
*Keywords*: Receiver function, uppermantle structure in Bulgaria, crustal thickness, Sredna Gora

**Yosifov, D., & Georgieva, G.** (2018). Structural features of the upper mantle in the area of the major deposits of non-ferrous metals in Bulgaria. *Geology and mineral resources*, (2–3), 3–9.

*Abstract*
An attempt is made to reveal some peculiarities in the construction of the upper mantle on the territory of the large deposits of non-ferrous metals in Panagyurishte region and in the Central Rhodopes. In the study, data are obtained with the methods of deep geophysics. Among the most important features of the upper mantle are: 1) Significant movement and rupture of fault at the Moho boundary and the upper part of the asthenosphere; moreover, the vertical amplitude of the Moho fracture is in the range of 13–14 km for the Madan ore field and 10 km and 8 km for Elshitsa-Radka and Elatsite-Chelopech ore fields (even larger is the amplitude of the rupture at the surface of the asthenosphere layer: 30 km for the Central Rhodopes and 60 km for Central Srednogorie); 2) For the first time are located faults entering the asthenosphere, which along with the traced seismic boundaries at a 150–700 km depth range are base for validation of its layer-block structure; 3) There was a high degree of heating of the Earth's crust and lithosphere in the two ore areas, which was mainly associated with the tectono-magmatic activations during the Upper Cretaceous and Paleogene; it is concluded that during these two periods the asthenospheric layer had risen upwards to the Moho boundary; 4) The proven significant activity of the endogenous processes in the asthenosphere and its geophysical characteristics allows us to assume, that the ore-forming processes, which are causal to

them, have been generated in the asthenospheric layer – a thesis of important theoretical significance.

**Georgieva, G., Dimitrova, L., & Gourev, V.** (2019). Ice generated events in Perunika Glacier, recorded by LIVV station. *Proceedings of the 10th Congress of the Balkan Geophysical Society*. https://doi.org/10.3997/2214-4609.201902661

*Abstract*

In this paper we present the initial results from our study of the seismicity generated by the processes in the Perunika glacier, Livingston Island, Antarctica recorded from Bulgarian broad band seismic station LIVV and its relationship with measured GNSS displacements on the glacier surface. Seismic and GNSS data from January 2018 were used. Different types of ice-generated events were observed. About 90 events with identical waveforms, very short duration (up to 1–2 s) and clear P and S onset were localized. GNSS measurements were carried out in five points on glacier and later the velocity in cm/day was computed.

**Georgieva, G., Dragomirov, D., Buchakchiev, V., Gourev, V., & Tzankov, L.** (2021). Activity of Glacier Perunika, Livingston Island, Antarctica as a result of changing temperature in the region. *21st International Multidisciplinary Scientific GeoConference SGEM 2021*, 51–58. https://doi.org/10.5593/sgem2021V/4.2/s19.09

*Abstract*

Glaciers are sensitive to climate change. How the fluctuation of the temperature affectsthe behaviour of the glacier and particularly its flow and seismic activity is underinvestigation. In this paper, we present a study of activity of glacier Perunika,Livingston Island, Antarctica using data from seismic station LIVV, GNSS data frompoint measurements on the surface of the glacier and meteorological data. GlacierPerunika is the closest one to the Bulgarian Antarctic Base. Seismic station LIVV, issituated near the glacier and about 1 km far from the Base. The station records datasince the astral summer of 2015. Two types of GNSS measurements on the glaciersurface were carried out: 1) 8 days long continuous recordings of the coordinates of onepoint which was situated close to glacier terminus; 2) measurement of the coordinates of15 points which were spanned on the upper part of the glacier. Meteorological data wascollected at one point near the Base. Joint analysis of the GNSS and meteorological datashows correlation between air temperature and the change in the surface velocity of theglacier. The change in the surface velocity follows the change in the temperature by 9hours. A change in the seismic activity of the glacier is also observed. The number ofregistered icequakes decreases as the astral winter approaches. The observed features ofthe glacier's behaviour can be explained by the melting of the deeper part of the ice withincreasing temperature. Thawed water flows close to the contact plane of the ice withthe earth's surface, reducing friction and changing the velocity of the glacier and thenumber of icequakes. Glacial seismic events are separated in several categories basedon their duration and amplitude. The data shows that the majority of the events have ashort duration (0-20 seconds) and most of them can be characterized as very weak (withan amplitude up to 15 counts). The data shows that events with duration 0-3 secondssignificantly increase with the arrival of the astral summer.

**Dimitrova, L., Georgieva, G., Raykova, P., Protopopova, V., Aleksandrova, I., Popova, M., Dimitrov, D., Gourev, V., Raykova, R., & Solakov, D.** (2018). Seismic activity of South Shetland Islands: Results from exploitation of first Bulgarian broad band seismic station in Antarctica. Annual of Sofia University "St. Kliment Ohridski", *Faculty of Physics, Jubilee Edition: New Scientific Achievements and Directions* in *the Faculty of Physics*, 35, 35–53., https://www.phys.uni-sofia.bg/annual/archive/indexJubEdit2.html

*Abstract*
Seismic station LIVV is deployed within three Antarctic expeditions from 2015 to 2018. During the first deployment period in astral summer 2015–2016 about 200 earthquakes were recorded. The estimated performance of the seismic equipment shows off the capabilities of the LIVV station to registered seismic events with different nature. Two methods for earthquakes localization are used. One is based on Golitsyn's method and Vincenty formulae and other is using DHypo software with different velocity models and phases from two Argentinean-Italian (AI) stations and four Spanish stations deployed on Deception Island Volcano.

**Georgieva, G., Dimitrova, L., Dragomirov, D., & Buchakchiev, V.** (2022). Seismic activity in Bransfield Strait, Antarctica between 2020 and 2022 as recorded using the seismic station LIVV. *Proceedings of the 3rd European Conference on Earthquake Engineering and Seismology*, Bucharest, Romania.

*Abstract*
Seismic activity in the Bransfield strait, Antarctica has increased since August 2020, accompanied by the strong earthquake from 23 January 2021. Only a few seismic stations in the region are in operation at the time and have recorded this seismic activity. Seismic station LIVV is situated on Livingston Island close to the Bulgarian Antarctic Base. In 2020 the station was moved to a new more quiet place and become permanent. For the period 2020-2022 more than hundred local and regional earthquakes were registered. Earthquakes are located using single station method and travel time table compute for the region. Most of the epicenters are located in Bransfield strait, but there are also many events with epicenters located in Drake Passage. Recorded earthquakes can be separated in four groups: seismic events with S minus P travel time about 12-13 s, located near Orca Seamount; events with S minus P travel time time about 25 s; events with S minus P travel time about 4-5 s and are located South-West from the seismic station and events with S minus P travel time about 11 s, located in Drake Passage. There also events that don't belong to any of the groups.
*Keywords* : Seismicity, Bransfield Strait, Livingston Island, single station localization

**Dimitrova, L., Georgieva, G., Afzali, J., & Dimitrov, D.** (2019). Broad band seismic sensors and their application: Case study – Livingston Island, Antarctica. *2019 XXIX International Scientific Symposium "Metrology and Metrology Assurance"*. IEEE. https://doi.org/10.1109/MMA.2019.8936018

*Abstract*
The aim of the paper is to present sensors for measuring the ground motion and a specific application related to recording seismic events on Livingston Island. The theory of operation of seismic sensors (seismometers) is described briefly. The basic parameters, classification and dynamic behavior of a seismograph system are discussed. It is considered the force-balance principle for constructing now a days seismometers. Some of the requirements for site selection and installation of seismometer are also commented on. Bulgarian broadband seismological station (with international abbreviation LIVV) is established on 19.12.2015near the Bulgarian Antarctic Base "St. Kliment Ohridski" on Livingston Island as a seasonal station. The deployment period of the station comprises three Antarctic campaigns in the

period 2015-2018. More than 12000 tectonic an ice generated events were recorded. The seismological equipment operates in harsh weather conditions with low temperatures, strong wind gusts and high humidity. In order to ensure optimal operation of the seismic station, special precautions are taken during the installation of the apparatus. The paper presents the assessment of the performance of the seismological equipment, power supply, data transfer solutions and technical problems met during the operational.

**Dimitrova, L., Georgieva, G., Raykova, R., Gurev, V., Aleksandrova, I., Raykova, P., Popova, M., & Protopopova, V.** (2015). Assessment of the efficiency of seismological equipment in extreme weather conditions in Bulgaria – first stage of Livingston Island seismicity study. *7th BgGS National Conference with International Participation "GEOPHYSICS 2015"*, S1 – Geophysics of the Earth Interior, S1-O3.

*Abstract*
Study of seismicity on Livingston Island and surrounding area is carrying out in the frame of the project DFNI I02/11/2014 "Creating an information base for study of seismicity and Earth's structure on Livingston Island and surroundings through complex research in the Bulgarian Antarctic Base area". Seismological equipment was installed on Vitosha Mountain and was working during February 2015 to test the performance of the equipment in extreme weather conditions. The seismological equipment included Broad Band seismometer CMG40T and Reftek 130 digitizer. The performance of the equipment was compared to the equipment working in stable environment in the Vitosha station. The assessment of the efficiency of the seismometer CMG40T and digitizer Reftek130 proved that the equipment is suitable to explore the seismicity of Livingston Island and surroundings. Different methods, as power spectral density noise distribution, receiver function technique, surface wave inversion, etc, will be implemented to study the natural phenomena in Antarctic region.

**Buchakchiev, V., Dimitrova, K., Georgiev, G., Georgieva, G., & Kozhuharov, V.** (2023). Pattern recognition and signal parameters extraction using machine learning methods. *Journal of Physics: Conference Series, 2668*, 012001. https://doi.org/10.1088/1742-6596/2668/1/012001

*Abstract*
Machine learning methods can be used for signal processing in different cases of physics research. A convolutional neural network was developed for the task of pulse counting in particle detectors for high energy physics. For the extraction of signal parameters was used a network with convolutional autoencoder architecture and a subsequent result reconstruction algorithm was developed and applied. A convolutional neural network was also developed for seismic studies with the task of identifying different events in seismograms. All of the algorithms with their architecture, input and output are presented and discussed.

**Yordanov, A., Gourev, V., & Georgieva, G.** (2026). Evaluating the impact of radiometric calibration and thermal noise removal on glacier velocity estimates from Sentinel-1 SAR data: A case study on Livingston Island. *Procs. of the Bulgarian Academy of Sciences, 79*(6), 742–750. https://doi.org/10.7546/CRABS.2026.06.05

*Abstract*
This study evaluates whether applying pre-processing to Sentinel-1 GRD (Ground Range Detected) SAR images alters the accuracy of glacier surface velocity estimates obtained with an offset-tracking algorithm. The pre-processing includes applying thermal noise removal and radiometric calibration deriving sigma0 type products. The research focuses on glaciers near the Bulgarian research base on Livingston Island (Antarctica), using available in-situ GNSS velocity measurements as ground truth. Three nearly identical processing chains were implemented in ESA's SNAP software: one including radiometric calibration

(producing sigma0) and thermal noise removal, one with only thermal noise removal, and one with neither. All other processing steps and parameters were held constant to isolate the effect of calibration and thermal noise removal.

**Chtirkova, B.; Peneva, E.; Georgieva, G**.; Numerical Weather Prediction for the Bulgarian Antarctic Base Area and Sensitivity to the SST Variable; S*tudies in Systems, Decision and Control*, 2021, 361, pp., 339–355, 10.1007/978-3-030-70190-1_23

*Abstract*

The weather forecast of good quality is essential for the humans living and operating in the Bulgarian Antarctic base (BAB), located on the Livingston Island coast at 62.64 S and 60.36 W. The numerical weather prediction models in southern high latitude regions still need improvement as the user community is limited, little test cases are documented and validation data are scarce. In this study, we suggest several ways to improve the local weather forecast model skill by modifications of the land cover and ocean temperature. We tested the sensitivity of the numerical weather prediction modelling system based on the Weather Research and Forecasting (WRF) model, configured for the BAB area, to the Sea surface temperature (SST) of the ocean around the island. The model configuration is described and details on the model performance are given. Several experiments with SST coming from different sources are performed, as well as experiments where the SST is scaled linearly. The conducted sensitivity experiments show that all of the considered meteorological variables are affected by the sea surface temperature, the most prominent differences being observed in the 2 m temperature field. With a uniform rise in SST, the corresponding tendencies are: an increase of the 2 m temperature, a decrease of the sea level pressure and an increase of the average wind speed. For the BAB region, the best results with unmodified SST data are obtained when using SST from the Copernicus Marine Service ocean model.

**Paskaleva, I., Nikolova, S., Dimitrova, L., & Georgieva, G.** (2010). Monitoring networks – Way for improving risk assessment from natural and manmade hazards: Case study salt mine Provadia (NE Bulgaria). *Acta Geodaetica et Geophysica Hungarica, 45*(3), 388–402.

*Abstract*

This work focuses on the assessment of seismic risk and the need of long-term studies on the territory of the only terrestrial Bulgarian salt deposit (Provadia, NE Bulgaria, 27.43E, 43.2N) in connection with the observed higher seismic activity and probable manifestations of technogenic seismicity in the region.

The necessity of regular monitoring of the geodynamic situation, surface subsidences and control of the mining excavations are discussed. A review of the manifestations of some observed problems due to the long-term mining is done. Some results of the performed monitoring at the site during the 1989–2009 are provided. Results of the analyses of the geological and seismotectonic situation, assessment of the stress-strain state of the salt diapir, surface subsidence, analysis of the recorded accelerograms, analyses of the seismic regime variation are discussed. The use of these analyses and their possible applications for the general stability assessment of the cavern-pillar system is formulated.

**Dimitrova, L., Nikolova, S., Georgieva, G., Raykova, R., Ivanova, I., & Asparuhova, I.** (2010). Processing and analysis of seismicity in Provadiya region in 3 year period. *6th National Geophysical Conference "20 Years Bulgarian Geophysical Society"*, Sofia, Bulgaria, 17 December 2010.

*Abstract*

The area around the town of Provadia is characterized by low seismicity. Since the beginning of the twentieth century up to 1980, earthquakes with magnitudes not exceeding 4.9 have been recorded. The

Mirovsko salt body, which has been exploited since 1956, is located in the vicinity of the town. Over the past 25 years, the number of local earthquakes has increased significantly.
Seismicity in the region is monitored by a local seismic network consisting of four permanent and two temporary stations, all equipped with modern broadband digital instruments. Seismic signals from the permanent stations are transmitted in real time to the National Seismological Centre at the National Institute of Geophysics, Geodesy and Geography, where they are processed by the automatic processing system together with data from the other stations of the National Digital Seismological Network.
For more accurate earthquake location and interpretation, seismic events in the Provadia region are processed interactively, incorporating seismic data from the two temporary stations and using a local seismic velocity model. During the analysis, criteria for reliable discrimination between local earthquakes and explosions are applied, as a large number of explosions are conducted at unidentified quarry sites. During the period from October 2006 to April 2009, 393 seismic events were located within a 25-km radius of Provadia, including 205 explosions, 184 earthquakes, and 4 unidentified events. Weak seismicity was observed along prominent and previously known fault structures in the region. A significantly larger number of earthquakes (96) occurred within the salt body and within 1 km of its southwestern margin. The earthquake magnitudes ranged from 1.2 to 3.1. The strongest earthquakes occurred on 5 November 2008 (ML = 3.9) and 7 October 2010 (ML = 4.2), both located within the boundaries of the salt diapir. Earthquake focal depths reached approximately 5 km. The appropriate configuration of the seismic network, the addition of temporary stations, and the application of the new velocity model improved the accuracy of earthquake parameter determination. In order to provide a more comprehensive quantitative assessment of the characteristics of the regional seismic regime, identify seismically active tectonic structures, and determine the origin of the recorded events—tectonic or anthropogenic—data need to be collected over a longer period of time.

**Georgieva, G., Radev, I., Popova, I., Mihaylov, E., Marinov, G., Ilieva, M., Matev, K., & Atanassova, M.** (2009). Complex investigation of the recent geodynamics in the region of Krupnik-Kresna. *Proceedings of the 5th Congress of the Balkan Geophysical Society*, Belgrade. https://doi.org/10.3997/2214-4609-pdb.126.6502

*Abstract*
The region of Krupnik and Kresna is situated in seismic active part of Bulgaria. The present activity is proved during the earthquake in 1904 and up to now the region is the most active in the territory of Bulgaria. The strongest earthquakes in Europe occurred in April 1904 with magnitude about 7,8. It was preceded from a strong foreshock with magnitude 7,1. In 2006 started a Young Scientist Project “Complex investigation of the recent geodynamics in the region of Krupnik-Kresna”. During the project there were made some seismic and gravimetric measurements in the region.

**Georgieva, G., Nikolova, S., & Dimitrova, L.** (2009). Monitoring of the seismicity in the region of LSN Provadia. *Proceedings of the 5th Congress of the Balkan Geophysical Society*, Belgrade. https://doi.org/10.3997/2214-4609-pdb.126.6520

*Abstract*
The Provadia region is located in seismically quite part of the Bulgaria – since the beginning of the last century no strong or moderate seismicity is reported, there also no historical evidences of strong earthquakes. Short after the beginning of exploration of the Mirovo salt dome several moderate earthquakes with magnitude greater than 4.0 were occurred in this region and caused damages to the neighboring villages. To improve the monitoring of the seismicity in the region a local seismological network was deployed in 1993.

**Georgieva, G., & Tzankov, C.** (2024). Estimation of sediment thickness of Sofia City from Horizontal-to-Vertical Spectral Ratio (HVSR) curve inversion. *Proceedings of the 12th Congress of the Balkan Geophysical Society*, 1–5. https://doi.org/10.3997/2214-4609.202149BGS27

*Abstract*
Recently climate change and active anthropogenic activity in the region of Vitosha Mountain have generated serious environmental problems in the forest fund. The increase of temperatures within territory of the Sofia Valley caused by several reasons, such as global warming, the active recreational activity of the inhabitants of Sofia and the rapid construction at the Vitosha foothills cause a significant reduction of the areas of natural vegetation. Based on the analysis of climatic data and processing of satellite images, the reduction of the size of the natural habitats of important plant communities had been observed. As an important indicator, the results of the analysis of the moisture index and the normalized vegetation index (NDVI) are used for the purposes of the study, based on data from Sentinel Hub. The analyzes show an critique decrease in the forest fund in the respect of the role and importance of the mountain as an ecological "island" within the territory of Sofia valley.

**Georgieva, G., Tzankov, C., & Kisyov, A.** (2022). Geophysical measurements of the southernmost microglacier in Europe suggest permafrost occurrence in the Pirin Mountains (Bulgaria). *The Cryosphere*, *16*, 4847–4863. https://doi.org/10.5194/tc-16-4847-2022

*Abstract*
There are no large glaciers in the territory of Bulgaria, but small patches of snow and firn have been observed in the high mountains at the end of summer. Perennial snow patches and microglaciers are considered indicators of permafrost occurrence. The results from the first detailed geophysical investigations of the Snezhnika glacieret, considered to be the southernmost microglacier in Europe, situated in the Golyam Kazan cirque, Pirin Mountains, Bulgaria, are presented in the paper. Ground-penetrating radar (GPR) and 2D electrical resistivity tomography (ERT) were used to estimate the thickness of the microglacier as well as its subsurface structure. Measurements started in 2018 and continued over the next 2 years in order to assess changes in its size and thickness. The mean thickness of Snezhnika is about 4–6 m, reaching 8 m or probably more in some areas. ERT measurements of the deeper parts of the microglacier beds show high electrical resistivities reaching over 60 000 Ωm at a depth of 4–10 m. An anomaly at this depth is likewise distinguishable on the GPR profiles. These anomalies are interpreted as permafrost areas and were consistently observed on the ERT and GPR profiles in the 2 years of the study. These results imply for the first time the existence of permafrost in the Pirin Mountains and in Bulgaria.

**Georgieva, G., Kisyov, A., Tzankov, C., Chtirkova, B., Gourev, V., & Ivanov, Y.** (2019). Evaluation of geophysical methods for studying snowfields in Pirin Mountain, Bulgaria. *Proceedings of the 10th Congress of the Balkan Geophysical Society*. https://doi.org/10.3997/2214-4609.201902662

*Abstract*
The article stages the results of surveys conducted in 2018 in the Pirin Mountain in order to evaluate geophysical methods for studying glacier thickness and structure. Two perennial snowfields are known in Pirin and the test investigations were carried out on one of them, situated in the area of Golyam Kazan. Ground penetrating radar (GPR) and 2D electrical resistivity tomography (ERT) were selected for the survey.

**Kisyov, A., Tzankov, C., Chtirkova, B., Georgieva, G., Ivanov, Y., Georgieva, B., Ishlyamski, D., Gourev, V., & Nikolov, S**. (2018). Study of perennial snow patches in Bulgaria. *In Proceedings of the IX National Geophysical Conference*, 30 November 2018, Bulgaria, pp. 119–126,

*Abstract*
The results of the surveys conducted in 2017 and 2018 in Rila, Pirin and Central Balkan mountains for the presence of perennial snow patches are presented. There was a higher number than expected - three in the region of Musala peak and more than ten in the valley of Banski Suhodol in Pirin. For all accessible patches we made GPS tracks of the snow area and then computed its size. In 2018 we carried out geophysical and meteorological measurements in Golyam Kazan in Pirin mountain, where „Snezhnika“ snow patch is situated.

**Georgieva, G., Stoyanov, N., & Dimovski, S.** (2021). Geophysical approach for mapping zones of low permeability endangering the stability of a tailings dam wall. *Proceedings of the 11th Congress of the Balkan Geophysical Society*, 1–5. https://doi.org/10.3997/2214-4609.202149BGS6

*Abstract*
The presented results confirm the applicability and high efficiency of the proposed integrated approach, based on the application of electrical resistivity surveys, exploratory core drilling, and wireline logging. It allows not only a reliable delineation of the studied zone of low permeability but also an evaluation of the efficiency of the installed relief wells. The acquired hydrogeological cross sections are of great importance for the development of an applicable technological solution regarding seepage control and the stability of the tailings dam wall.

**Georgieva, G., & Kisyov, A.** (2021). Multidisciplinary approach for fluvial architecture modelling and reservoir properties estimation. *Proceedings of the 11th Congress of the Balkan Geophysical Society*, 1–5. https://doi.org/10.3997/2214-4609.202149BGS11

*Abstract*
A multidisciplinary study conducted as practical training for students is presented. It combines detailed lithofacial profiling and 2D mapping of the surface outcrop. In addition to the classical geological methods that were represented, the possibilities of different geophysical methods (2D electrical resistivity, seismic, seismology (H/V spectral ratio), gravimetry, magnetometry, georadar, and aero photogrammetry) were also demonstrated in the study. Based on the conducted geophysical and geological measurements main sedimentary sequences were delineated and an attempt was made to track them spatially within the studied area.

**Kisyov, A., Tzankov, C., & Georgieva, G.** (2023). A comprehensive practical training in geophysics and geology for students supplements the studies at the university. *Annual of University of Mining and Geology "St. Ivan Rilski", 66*, 150–153. https://doi.org/10.5281/zenodo.8334625

*Abstract*
In 2019, 2021, and 2022, practical training for students in geophysics and geology was conducted. During the training, the geology of the selected area was shown, and geophysical methods were demonstrated in the study of characteristic geological structures. The measurements were taken by the participating students. In this way, they had the opportunity to get acquainted with the complex geological and geophysical work in the study of a certain area. The training also included presentations to introduce the theory of the methods themselves, as well as a final seminar where the results of the measurements were

presented.

**Solakov, D., Simeonova, S., Aleksandrova, I., Popova, I. & Georgieva. G.** (2009). Earthquake scenarios: Case study for the cities of Ruse and Vratsa. *In Proceedings of the 5th Congress of the Balkan Geophysical Society. EAGE.* https://doi.org/10.3997/2214-4609-pdb.126.6497

*Abstract*
The present study deals with deterministic seismic scenario generation based on macroseimic intensities, generated by damaging, real earthquakes of the past. The both cities scenarios are representation of the severity of ground shaking over an urban area. The work on scenarios was guided by the perception that usable and realistic ground motion maps had to be produced for urban areas. The differences in local geological and geotechnical characteristics, and urban features of the cities has made it necessary to apply different alternative of the approach sufficiently flexible to account for the basic factors in the different situations. Such scenarios are intended as a basic input for developing detailed earthquake damage scenarios for the cities and can be used in earthquake-safe town and infrastructure planning.

**Simeonova, S., Aleksandrova, I., Solakov, D., Popova, I., & Georgieva, G.** (2006). Observed macroseismic effects from intermediate Vrancea, Romania earthquakes (1940, 1977) on the territory of the town of Rousse. *Geosciences 2006:Procs. of the Nat. Conf. with International Participation*, 212–214.

*Abstract*
The city of Rousse is located on the right bank of the Danube river, in the mouth of Rusenski Lom River. Its population is about 162 000 people. The city is an administrative, transport and tourism centre of Bulgaria. The earthquakes that mainly influence the hazard in Rousse are the intermediate Vrancea (Romania) earthquakes. The macroseismic effects distribution (from 1940, M=7.3 and 1977, M=7.2 Vrancea earthquakes) is presented in the study. In both cases, the strongest effects along the Danube river are observed.

**Solakov, D., Simeonova, S., Christoskov, L., Aleksandrova, I., Popova, I., & Georgieva, G.** (2009). Earthquake scenarios for the cities of Sofia, Rousse, and Vratsa. *Information & Security: An International Journal, 24*, 51–64. https://doi.org/10.11610/isij.2406

*Abstract*
Global seismic hazard and vulnerability to earthquakes are increasing steadily as urbanization and development occupy more areas that are prone to effects of strong earthquakes. The uncontrolled growth of mega cities in highly seismic areas around the world is often associated with the construction of seismically unsafe buildings and infrastructures, and undertaken with an insufficient knowledge of the regional seismicity peculiarities and seismic hazard. The assessment of seismic hazard and generation of earthquake scenarios is the first link in the prevention chain and the first step in the evaluation of seismic risk. The territory of Bulgaria (situated in the eastern part of the Balkan Peninsula) represents a typical example of high seismic risk area. Over the centuries, Bulgaria has experienced strong earthquakes. The strongest earthquakes reached magnitude 7.8 in southwestern Bulgaria, magnitude 7.5 in northeastern Bulgaria, and magnitude 7.0 in southern Bulgaria. Moreover, the seismicity of the neighboring countries, like Greece, Turkey, former Yugoslavia and Romania (especially Vrancea-Romania intermediate earthquakes), influences the seismic hazard in Bulgaria. In the present study earthquake scenarios for three Bulgarian cities (Sofia, Rousse and Vratsa) are presented. The scenarios were generated using deterministic approach that was applied in the European project Risk-EU (2001-2004). Such scenarios are intended as a basic input for developing detailed earthquake damage scenarios for the cities and can be used in earthquake-safe town and infrastructure planning.