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Original scientific paper

DEINING THE NET OF GEOMAGNETIC REPEAT STATIONS IN THE REPUBLIC OF KOSOVO

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A b s t r a c t: This paper presents the necessary procedures that should be conducted for definition of net of repeat stations on the territory of the Republic of Kosovo, according the INTERMAGNET standards. (Rasmussen and Kerridge, 2002). For complete monitoring of the geomagnetic field in a given space, it is necessary to have a basic network of stations for periodic field observation and a geomagnetic observatory that permanently measures the temporal changes of the geomagnetic field. To define the coefficients of dependence of the geomagnetic field on the latitude and longitude of a given point for a certain space (usually a state), in addition to the existence of a geomagnetic observatory which is a benchmark, requires a relatively homogeneous network of geomagnetic stations. For that purpose, detailed field measurement should be performed for definition of the several repeat stations which will compose the net of the repeat stations on the territory of the Republic of Kosovo. The basic network of geomagnetic stations is used for periodic measurements of those points in an interval of 3 to 5 years. For a given epoch (period of five years) the value of any component of the geomagnetic field can be calculated for a given point belonging to the space (state) that covers the geomagnetic observatory with coordinates φ_o and λ_o.

Key words: procedures; repeat stations; definition; net; intermagnet

INTRODUCTION

Earth has had its magnetic field since the beginning of its formation as a planet with its geospheres. Along with the formation of rocks, thanks to the content of ferromagnetic minerals, they also acquired their magnetic memory. In this way, each rock remembers the character of the Earth's magnetic field at the place where the rock formed and at a time when it formed and cooled. Based on the magnetic memory of the rocks, it is possible to determine the position of the continental masses during the last 500 million years. By studying the magnetic memory of rocks, the process of continent formation and their separation and collision has been reconstructed.

The Earth's magnetic field is studied by examining the earth itself (terrestrial), but also by examining it from airplanes and satellites. Thus, the modern character of the Earth's magnetic field on its surface and in the space around the Earth, which is defined as the magnetosphere, is studied, its changes during 24 hours, which are called daily variations, then the changes that occur throughout the year and continue from year to year, hence they are also called secular or centuries-old variations (Delipetrov, 2003),

In the period of time, which is determined as geological time, the Earth's magnetic field changed its polarity and this phenomenon is called magnetic field reversal. Magnetic rocks and ore deposits rich in magnetic minerals deform the normal magnetic field and in some parts of the Earth's magnetic field anomalies occur. Based on these anomalies, ore deposits can be found and the mutual relationship of rocks can be studied.

The technique of measuring the elements of the magnetic field with instruments placed in the satellites, contributes to the study of the magnetic field outside the magnetosphere. Thus it is determined that the Moon does not have its own magnetic field. When the first rock samples were taken from the Moon, their study concluded that many minerals were magnetic but did not have remanent magnetization. This proves that the Moon never had its own magnetic field.

ELEMENTS OF THE GEOMAGNETIC FIELD

The geomagnetic field of the Earth at any of its points or in the domain of the magnetosphere can be represented by a vector that is the tangent to the magnetic lines of force at the measuring point. A common notation for a geomagnetic field vector is $\vec{T}$ or $\vec{F}$. The vector module defines the intensity of the geomagnetic field at the point of observation. The vertical plane in which the vector of the geomagnetic field lies is also called the magnetic meridian.

If the beginning of the rectangular coordinate system is placed at the measuring point (Figure 1), whose plane *x*O*y* is horizontal, the *z*-axis is oriented downwards (towards the center of the Earth), and the *x*-axis is set to lie in the plane of the geographical meridian and it is oriented to the north, then the *y*-axis is oriented to the east. In such a coordinate system, the vector of the geomagnetic field can be decomposed into components, and its position in space can be determined by the angles it occupies with its projections in the selected coordinate system.

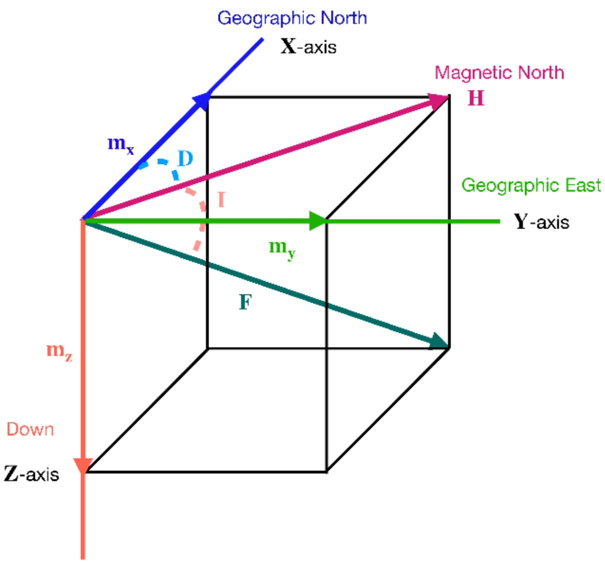

Fig. 1. Sketch of the elements of the geomagnetic field of the Earth

The angle *D*, which the plane of the magnetic meridian at point O creates it with the geographic meridian, is called the declination. In other words, that is the angle that the horizontal component X of the vector of the geomagnetic field *T* occupies at with the positive part of the *x*-axis. If the vector X is deviated eastward from the positive *x*-axis, then the declination is positive or eastward, and if the vector X is deflected westward relative to the positive *x*-axis, then the declination is negative or westward.

The horizontal component *H* of a geomagnetic field can be decomposed into two mutually perpendicular components, so that:

$$\vec{H} = \vec{X} + \vec{Y},$$

where:

$\vec{X}$ – is a projection of the *H*-component on the *x*-axis and is called the north component;

$\vec{Y}$ – is a projection of the *H*-component on the *y*-axis and is called the east component.

Since the vector with the horizontal plane *x*O*y* occupies an angle *I*, which is called the inclination of the geomagnetic field, then:

$$\vec{H} = \vec{T} + \cos I$$

similarly:

$$\vec{X} = \vec{H}\cos D$$

$$\vec{Y} = \vec{H}\sin D$$

The projection of the vector on the *z*-axis is called the vertical *Z*-component of the geomagnetic field and it is expressed by the equation :

$$\vec{Z} = \vec{T}\sin I$$

Declination *D*, Inclination *I*, horizontal *H*, eastern *Y*, north *X* and vertical *Z* component, as well as the vector T are called magnetic field elements.

Some of the relations between the elements of the geomagnetic field are:

$$\vec{T} = \vec{H} + \vec{Z}$$

$$\mathrm{tg}D = \frac{Y}{X}$$

$$\vec{Z} = \vec{H}\,\mathrm{tg}I$$

The intensity of the elements of the geomagnetic field is expressed in nanotesla (nT) in SI, oersted [Oe] in CGSM, or [gamma], whereby

$$1\ \text{gami} = 1\cdot 10^{-5}\ \text{Oe} = 1\ \text{nT}$$

The values of declination *D* and inclination *I* of the geomagnetic field are expressed in degrees.

To define the vector T of the geomagnetic field in space, three mutually independent quantities need to be known:

- Two angles and one component, for example *D*, *I* and *Z* or *D*, *I* and *H*;
- Two components and one angle, for example *H*, *Z* and *D* or *X*, *Y* and *I*;
- Three components, *X*, *Y* and *Z*.

In all cases it is necessary to know the value of the declination *D*. The classical method of determining the orientation of the vector T in the geomagnetic field consists in measuring the absolute values of the horizontal component *H*, the declination *D* and the inclination *I*.

GEOLOGY OF THE REPUBLIC OF KOSOVO

Kosovo is a small and landlocked disputed territory in Southeastern Europe. The country is strategically positioned in the center of the Balkan Peninsula enclosed by Montenegro to the west, Serbia to the north and east, North Macedonia to the southeast, and Albania to the southwest (Figure 2).

The country possesses impressive and contrasting landscapes determined by the climate along with the geology and hydrology.

The country is a quite rich country for its water sources, there are many long and short rivers, as well as artificial and natural lakes around the country.

The climate of the country is mostly defined by its geographical location and it is a combination of a continental climate and a mediterranean climate.

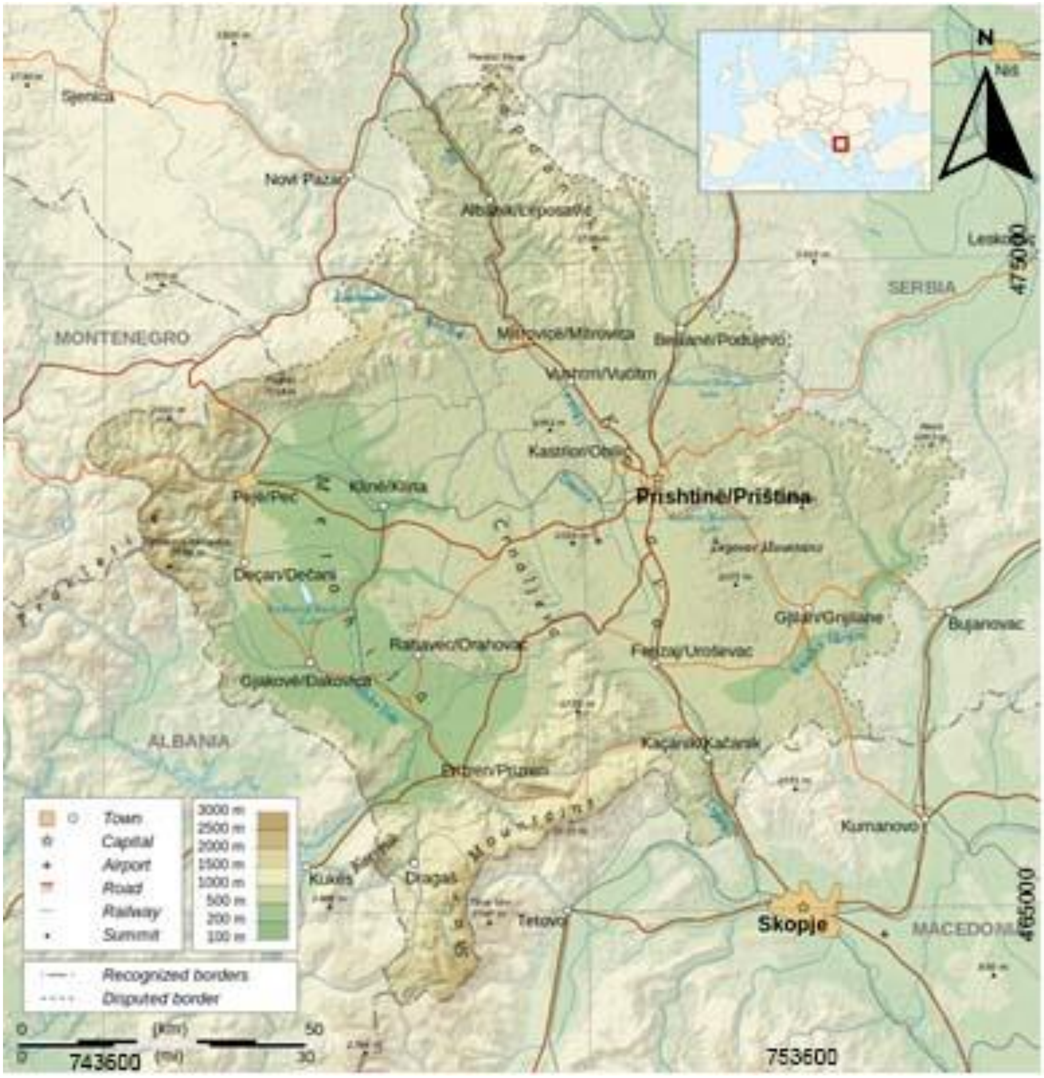

Fig. 2. Geographical map of Kosovo

Kosovo has a varied geology that ranges in age from the Neo-Proterozoic to the Holocene. The geology is characterized by substantial structural features on a regional scale, including normal faulting and thrusting [https://kosovo-mining.org/mineral-resources/geology/?lang=en].

A general simplification of the stratigraphic sequence is as follows.

- Holocene: scree formed from weathering of mountains and alluvium deposited by the rivers.
- Pliocene: andesitic chert.
- Upper Miocene-Pliocene: formation of lignite from the accumulation and subsequent decay of vegetation in sedimentary basins.
- Oligo-Miocene: conglomerates, clays and limestones, accompanied by acidic to intermediate magmatism.
- Late Cretaceous "molasses": shallow-water carbonates and clastic.
- Upper Cretaceous "flysch": marly limestones, sandstones and conglomerates.
- Early Cretaceous: conglomerates, sandstones and silts.
- Late Jurassic: massive limestones.
- Triassic-Jurassic: basic and acidic magmatism, and associated ophiolitic crustal rifting and obduction of ultrabasic rocks.
- Triassic: clastic with volcanic giving way to carbonate platforms that grade up into dolomites, some of which have been metamorphosed to marble.
- Perm-Triassic: carbonates, clastic, phyllite, schists and quartzite that have been invaded by acidic magmatism (quartz porphyries).
- Late Palaeozoic: schists.
- Neo-Proterozoic-Palaeozoic: basement of schists, gneisses and amphibolite that have been invaded by granitic plutons.

The oldest rocks form the Neo-Proterozoic basement, which is composed of crystalline schists and granites, representing the products of regional high-grade metamorphism. These rocks mostly occur in the north-eastern part of Kosovo.

Over the continental basement was an extensive sequence of shallow water marine sediments (clastic and chemical) of Late Permian to Early Triassic age that were invaded by acid magmas as the continental crust thinned, resulting in the anatexis of pre-existing rocks. Continued stretching and thinning led to physical separation of the continental crust, resulting in the extrusion of basalt, hosting highly irregularly shaped pods of high-grade chromite. This separation was extensive enough to lead to the formation of the Paratethys Ocean that ran across the Balkans, including Kosovo.

The Paratethys was a branch of the main Tethys Ocean that ran across Southern Europe, the Mediterranean and North Africa. A reversal of tectonic plate movement led to the eventual closure of the Mesozoic-age Tethys Ocean, including a segment called the Vardar Ocean (Paratethys) that ran across Kosovo. By late Jurassic times, the presence of a remnant Vardar Ocean as a shallow sea, led to the chemical deposition of thick and extensive carbonate platforms.

By Cretaceous times, the eventual retreat of this sea and the stability provided as a passive continental margin, led to the deposition of clastic sediments that range from marine to terrestrial in origin. Collision between the landmasses that had flanked the Vardar Ocean forced the westward obduction of remnants of oceanic crust upon continental crust. The result is the remnants of oceanic crust found throughout the Balkans, forming linear ophiolitic sequences aligned along the regional NNW-SSE structural trend. These obduction events are polyphase and would appear to represent crustal accretion, resulting in the development of several linear belts of ophiolites, ranging in age of obduction from Jurassic to Cretaceous. The rocks that were overthrust during the emplacement of ophiolites are called the 'sole'; rocks and form units called mélange. Such ophiolitic mélanges are characteristically composed of chert, serpentinite, mafic volcanics and carbonates, all of which may be in the form of fragments within chaotically sorted olistostrome units.

In Late Cretaceous times, extensive continental collision during the Alpine Orogeny led to the formation of the Alps and associated mountain ranges throughout central and southern Europe. The rapid erosion of these contorted rocks of both marine and continental origin resulted in the deposition of the flysch cover sequence, composed of marly limestones and clastics. As the Alpine Orogeny waned, so the young mountain ranges were eroded to produce the continental molasse cover, sequence that formed predominantly in intermountain basins throughout the Alpine zone. Some of the continental clastic sediments preserved in Kosovo probably represent molasse deposits (Figure 3).

Basin depressions in Kosovo represented extremely favourable places for vegetation growth that finally became overwhelmed by sedimentation and led to the formation of the substantial stratiform lignite deposits. The Pleistocene glaciations that affected Europe removed much of the soil cover from Kosovo's ring of surrounding mountains, leading to the formation of substantial talus deposits along the steep mountain flanks.

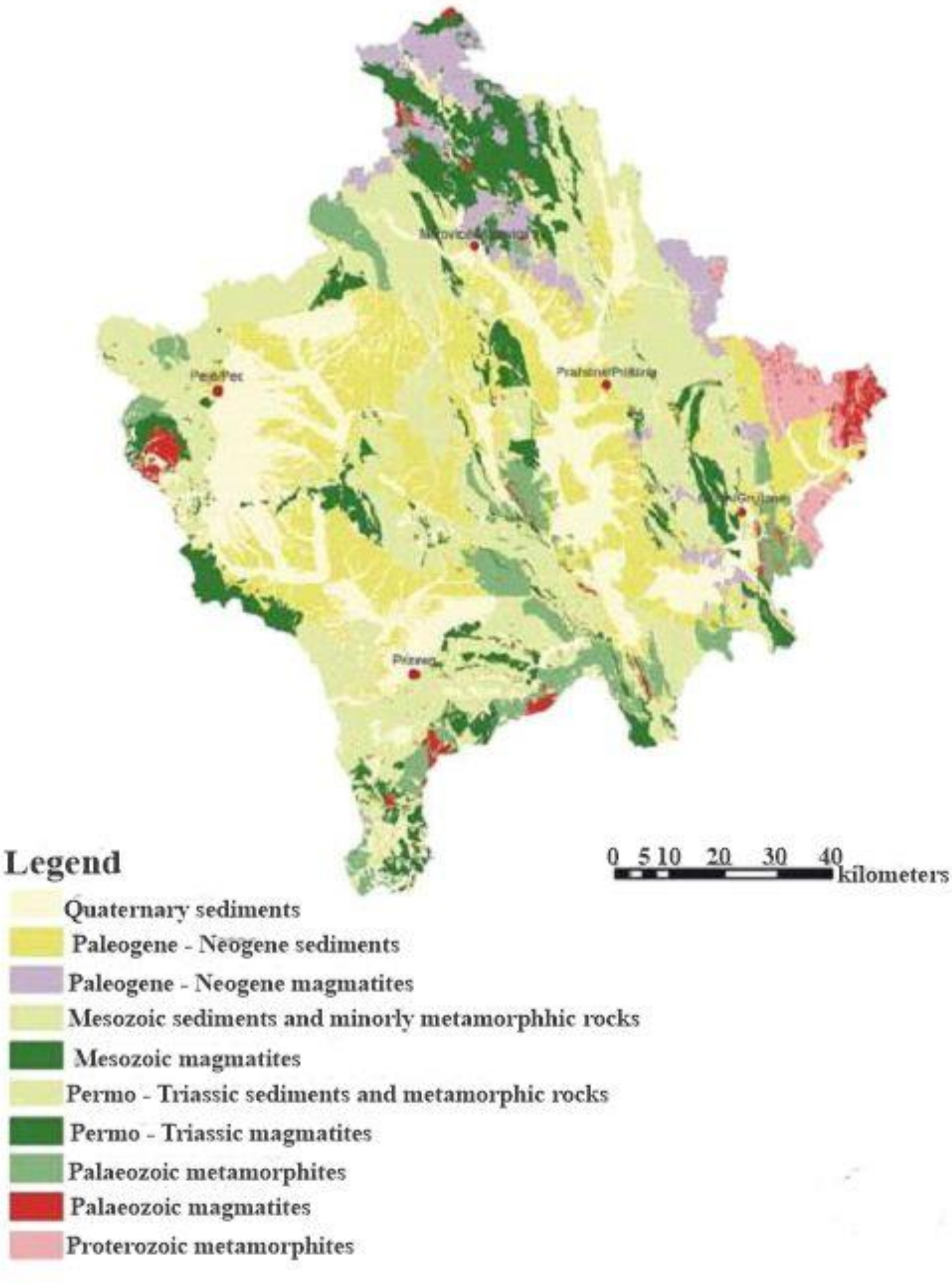

Fig. 3. Map of Kosovo geology (Elezaj, 2018)

Tectonic structure of Kosovo

Structurally, Kosovo is geologically divided into two roughly equal-sized halves (the Vardar zone to the east and the Drenica (Drina – Ivanjica)/Korabi – Pelagonian zone to the west) by the NNW-SSE trending suture between the Dardania massif (Serbo-Macedonian) in Kosovo and the Dinaric geological belt of Albania. The Mesozoic transform fault zone, the so-called Shkoder-Peje lineament, divides the Drina and the Korabi into two separate zones. The Vardar zone is economically important as it hosts the Trepcha lead-zinc-silver deposits. These deposits vary from carbonate-hosted skarns and karst fillings to vein deposits (Figure 4).

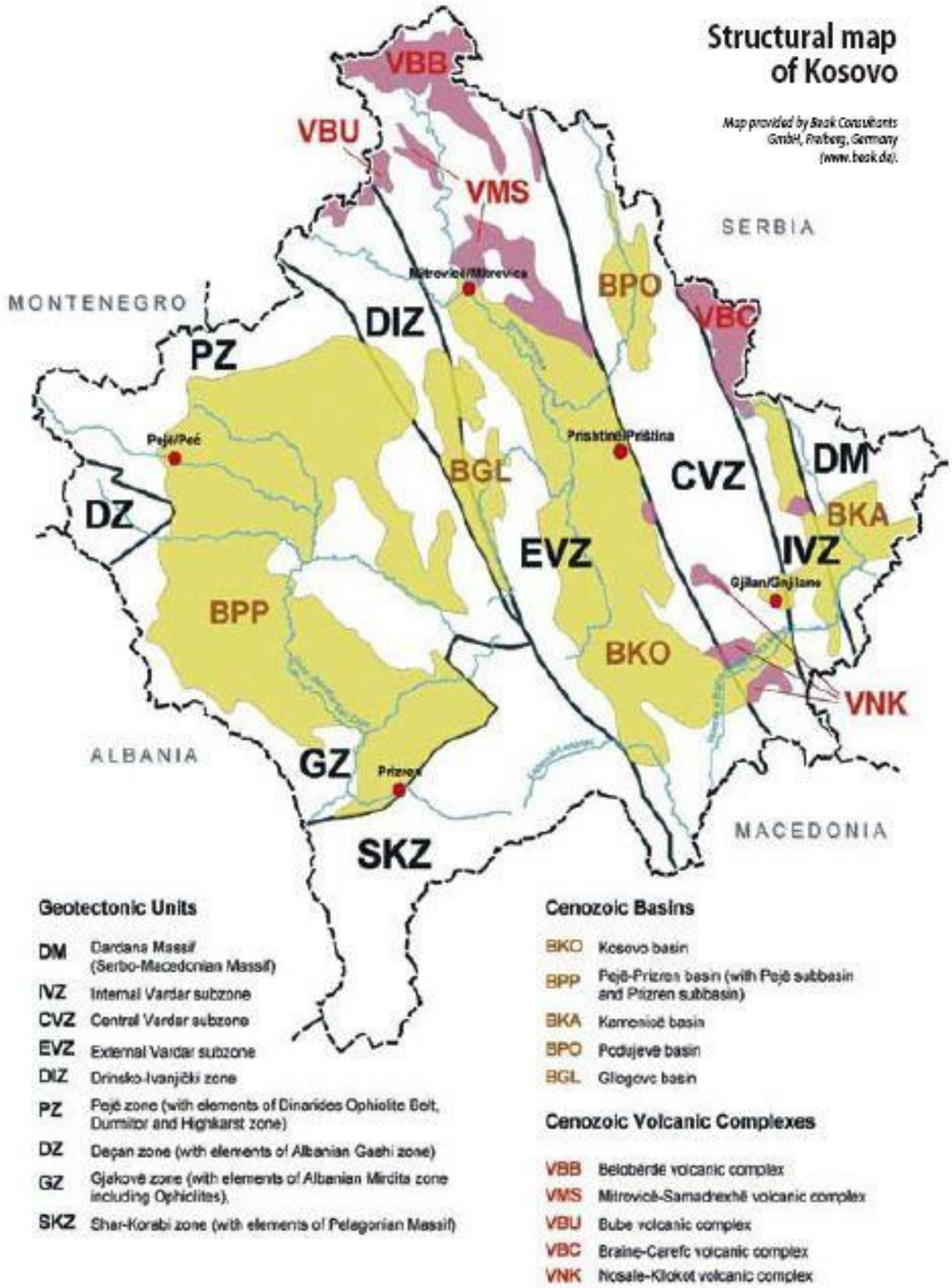

Fig. 4. Structural map of Kosovo [Elezaj, 2018]

The Mesozoic limestone platforms have been fractured by several generations of faults oriented in different directions. The limestones are reactive rocks capable of absorbing minerals-rich heated brines, and the metals came out of solution in these favourable horizons. The Vardar zone may have originated either in the Early Palaeozoic, as part of the Palaeo-Tethys that separated Gondwanaland to the south from Eurasia in the north, or in the Triassic, similar to the present-day Red Sea oceanic basin.

Final closure of the Vardar Ocean is unclear and may have occurred in either the Cretaceous or Early Tertiary. The formation of the ophiolites via ocean closure and thrusting is important in that the ultrabasic units host chrome, and these serpentinised rocks break down under tropical to sub-tropical weathering over time to produce accumulations of bauxite and lateritic nickel. The bauxite deposits in west-central Kosovo are hosted in karst limestone and represent the remnants of these weathered ultrabasics.

During 2006–2007, in Kosovo has been conducted an airborne geophysical survey, which was carried out by the British Geological Survey and the Geological Survey of Finland. With these measurements, i.e. from the results obtained with the measurements, was created geomagnetic map of total intensity on the territory of the Republic of Kosovo (Figure 5) (Kastrati, and Krasniqi, 2015).

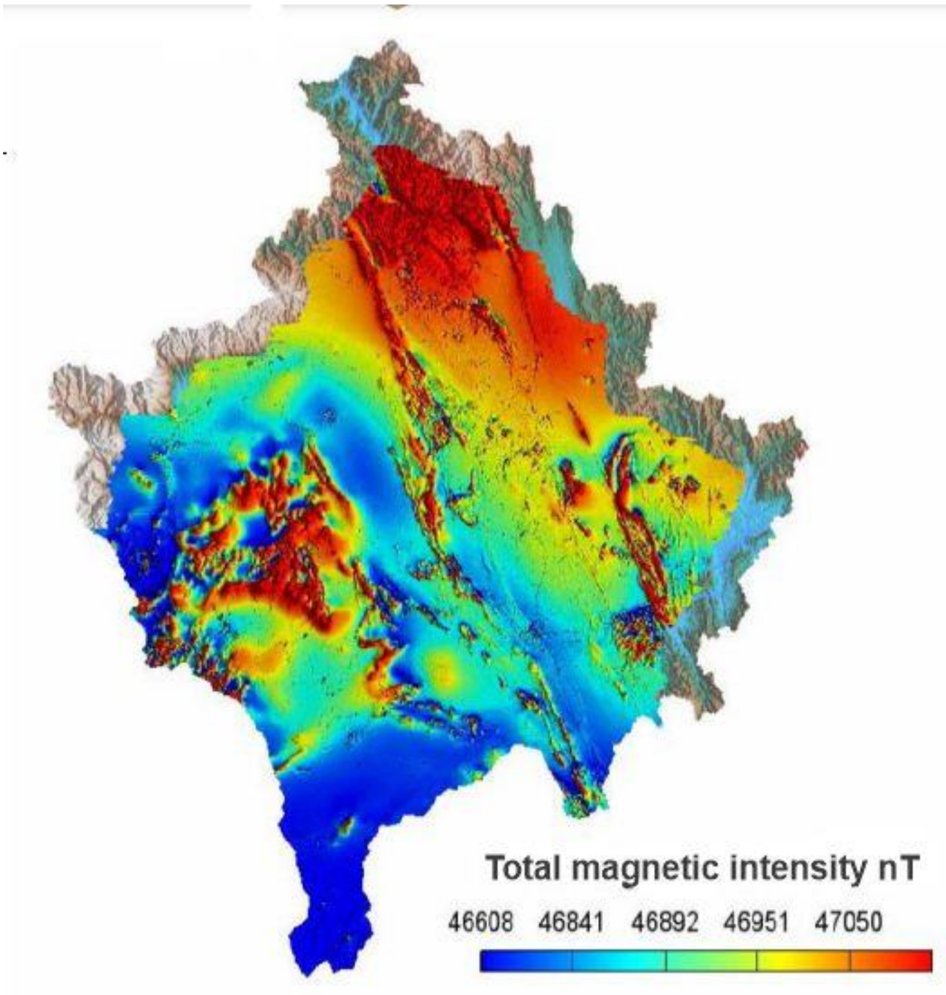

Fig. 5. Map of total magnetic intensity of Kosovo [Kastrati and Krasniqi, 2015]

MATERIALS AND METHODS

Basic elements for defining a magnetic station

Position selection

It has been practically shown that many of the magnetic stations that are currently being measured are facing a dangerous situation, due to the increasing effects of the industrial impact that exceed the maximum allowed standards, so there is an urgent need to move the station to another location..

It is therefore of great importance, when chosing a site for magnetic stations, to pay attention to the magnetic purity of the site not only in the epoch of construction, but also in the foreseeable future [Sas-Uhrynowski et al., 2003].

Magnetic stations are planned for long continuous operation over several decades. This means that at the time of that foreseeable future, there should be no plans to build industrial projects and settlements, railways, pipes and high-voltage power lines near the station. In terms of magnetic measurements, especially serious obstacles coming from electrified railways, so they must be placed at a distance of at least 1 km from the station.

For the possible location of the magnetic station, engineering-geological maps should be used to check the stability of the terrain for the installation of stable pillars for the instruments. Magnetic surveys in a radius of 100 m and a step of 10 m should also be performed. To take into account variations in the geomagnetic field, the test should be performed using two proton magnetometers. On the territory of the station, detailed magnetic survey should be performed with a step of 1m. The magnetic field gradients should not exceed 1–2 nT/m.

If the results of the initial magnetic measurements meet the introduced requirements, the marked area can be used for setting up a geomagnetic station. It should be legally protected from possible later threats by local authorities, external organizations and individuals.

Astronomical azimuth of the sign / target

If a large structure at a distance of 1–2 km from the absolute observatory hut is not available for use as a sign of astronomical azimuth, it is necessary to make a special azimuth sign to determine the direction of the magnetic meridian in space measured with a declinometer.

Signal stability requirements depend on the distance of the observation pillar from the absolute hut to it. The permissible deviation of the sign ΔA under the influence of the environment is determined by the formula:

$$\Delta A = L \sin \Delta D\ .$$

If the declination measurements are made in the magnetic observatories with an allowable error of ΔD = 0.1 arc min, the mark is made at a distance of 100 m, then the deviation from its position does not exceed 3 mm. It is necessary to place fluxgate declinometers on the instrument pillars in the absolute hut with the same accuracy. These are strict requirements for the placement of the mark and the position of the pillar instrument. If the distance of the sign is 350 m, then the error ΔA increases to 1 cm. The sign distance of 350 m can be taken as the minimum distance [Barton, 1992].

The surface for construction of the sign and its required height should be cleaned in the direction of the view of the theodolite pipe from the pillar with open small glass on the pavilion. On the selected surface it is necessary to dig a hole with a size of 2x2 m and to take out the ground and to drill a hole with a depth of about 2 m. A steel or casted iron pipe with a diameter of at least 120 mm is placed in the hole with lead plumb which is fastened using concrete or a reinforcer. The point of attachment of the sign is marked on the pipe in accordance with the direction of the theodolite. The simplest sign is made in the form of an aluminum angle piece that can be rotated around the created axis of the pillar. The bright line on the base of the black pillar is well seen even in cloudy weather. A more complex feature of the sign is a steel plate with an isosceles aluminum triangle. At the required height the tile can be rotated on the pipe. Observations at night or in winter in polar night conditions require the sign to be illuminated by a spotlight and face directly towards the absolute pavilion. Unstable position of the sign or misalignment of the declinometer towards the sign will result in poor quality of magnetic declination measurements.

RESULTS AND DISCUSSION

Measurement with a proton magnetometer

Geomagnetic observation with the proton magnetometer is a simple procedure. In fact, it is so simple that people tend to forget the usual precautions which must be taken in order to make correct magnetic measurements. We can identify the following steps (Rasson, 2005):

1) Set-up the proton magnetometer sensor at the place where a measurement is needed.

2) Ensure that the place of measurement is free from high magnetic gradients or strong electromagnetic radiation, like those generated by high power mains lines.

3) Orient the sensor correctly with respect to the field direction.

4) Connect the electronic console and position it at a sufficient distance for it not to produce magnetic disturbance on the sensor.

5) Tune the sensor to the local field value.

6) Ensure that the observer operating the console is not magnetic.

7) Perform a measurement by depressing the measurement trigger.

Steps 1 and 3 need a special fixture like a tripod and/or a stative in order to set-up and orient the sensor stably at its place and with the correct orientation. In general, the sensor will bear a mark "N" which should point to the geomagnetic North. If there is no mark, the cylindrical sensor should be oriented with its axis normal to the field and horizontal.

Point 4 depends on the magnetic signature of the console. Often the console is put too close to the sensor for ensuring an effect less than 0.1 nT. In that case it is necessary to extend the cable between both items. Note that the magnetic signature of the console is dependent on the batteries used in it.

Point 5 provides a good test for meaningful measurements: similar values of the field should be obtained for the correct tuning value and the neighbouring values of the tuning

Diflux measurements and absolute measurements with proton magnetometer

This calculation algorithm is based on a special series of Diflux measurement protocol, which must be followed in order to achieve accurate results. The time order for the *D* and *I* measuring positions is as follows:

1) Measurement of declination:

D_1: Telescope to East, sensor up

D_2: Telescope to West, sensor down

D_3: Telescope to East, sensor down

D_4: Telescope to West, sensor up

2) Measurement of inclination:

I_5: Telescope to North, sensor up

I_6: Telescope to South, sensor down

I_7: Telescope to North, sensor down

I_8: Telescope to South, sensor up

In this calculation is assumed that the baselines of the variometer do not change in the time of the measurement and that there are no changes in the magnetic gradient between the point of absolute measurement and the point of variometer measurement.

We can count on two time-matched options for measuring the total field (module) *F*. They may or may not have to be synchronized with the measurements of *I*, depending on the availability of continuous registration of *F*. They will be marked as: F_5, F_6, F_7 and F_8, when synchronized.

Measurements with DFI variometer

In this case the vector components measured with Diflux and the variometer are identical. The components of the measurement are therefore completely connected and all components are independent of each other. The basic magnetic relations between absolute and variometric measurements are:

$$D = D_0 + dD$$
$$I = I_0 + dI$$
$$F = \mathrm{F}_0 + dF$$

These equations are calculated for each measurement step. The index "0" indicates the baseline, while the prefix "*d*" indicates the variometric measurements in nT. We change nT into angular units with (Rasson. 2005; Mandea and Korte, 2011):

$$D_0 = D \text{- atan}\left(\frac{dD}{H_m}\right)$$

$$I_0 = I \text{- atan}\left(\frac{dI}{F_m}\right)$$

If *dD* and *dI* are small (such are in normal field conditions and for a well-adjusted variometer), then arctg can be calculated using mean annual values for *H* and *F*. In the equations, H_m and F_m are mean annual values. Baselines are given with:

$$D_0 = \frac{(D_{01} + D_{02} + D_{03} + D_{04})}{4}$$

$$I_0 = \frac{(I_{05} + I_{06} + I_{07} + I_{08})}{4}$$

$$F_0 = \frac{(F_{05} + \mathrm{F}_{06} + F_{07} + F_{08})}{4}$$

Defining the coefficients of dependence of the geomagnetic field on the latitude and longitude of a given point for a given country, requires a relatively homogeneous network of geomagnetic stations (Rasson, 2005; Brkić., 2005).

The basic network of geomagnetic stations serves for periodic measurements of those points in an interval of 3-5 years and based on the equation:

$$E(\Delta\phi, \Delta\lambda) = a_1 + a_2\Delta\phi + a_3\Delta\lambda + a_4\Delta\phi^2 + \\ + a_5\Delta\lambda^2 + a_6\Delta\phi\Delta\lambda,$$

where

$E(\Delta\varphi, \Delta\lambda)$ – value of the normal field of the point whose geographical coordinates are φ_1 and λ_1;

φ_1, λ_1 – latitude and longitude of the place;

φ_0, λ_0 – latitude and longitude of the point in relation to which the measurements are made;

$\Delta\varphi = \varphi_1 - \varphi_0$ – latitude difference in minutes;

$\Delta\lambda = \lambda_1 - \lambda_0$ – longitude difference in minutes;

a_i – coefficients of the corresponding difference γ /minute, i.e. minutes/minutes or gamma and minutes.

For a given epoch (period of five years) the value of any component of the geomagnetic field can be calculated for a given point belonging to the space (state) that covers the geomagnetic observatory with coordinates φ_0 and λ_0.

Reduction technique

To reduce the field magnetic data to annual mean data, we use the data from the neighbouring countries. The data reduction procedures and formulae are as follows (Delipetrev et al., 2007):

Knowing that the repeat survey gives us a measurement of *D* in station *Stat* at the epoch *t*, we have: $D_{stat}(t)$, and that a nearby Observatory *Obs* supplies us with a measurement in the observatory at the same epoch *t*: $D_{Obs}(t)$, as well as an annual mean in the observatory for epoch *a*: $\overline{D}_{Obs}(a)$.

If we want to calculate the annual mean in the station *Stat* for epoch a, than we have: $\overline{D}_{Stat}(a)$.

It is postulating that:

$$\overline{D}_{Stat}(a) - \overline{D}_{Obs}(a) = D_{Stat}(t) - D_{Obs}(t) \quad (1)$$

Hence it is obtained that the annual means at epoch *a* at station *Stat* for the component *D* is:

$$\overline{D}_{Stat}(a) - \overline{D}_{Stat}(a) = D_{Obs}(t) - D_{Obs}(t) \quad (2)$$

The validity of the above postulate (1) depends mainly on the differences in daily variation between *Stat* and *Obs* and hence is influenced by:

– Distance in longitude and latitude between *Stat* and *Obs*,
– Geomagnetic field activity,
– Time in the day and $t - a$.

This reduction should be performed for each measured component.

Discussion

Such measurements were conducted on the territory of Macedonia in 2004 on 15 repeat stations. The instrumentation that was used for this purpose was as follows (Rasson and Delipetrov, 2006):

– Proton magnetometer G816.
– Zeiss 010 Diflux (Mingeo demagnetization) with Pandect fluxgate sensor and 1" accuracy.
– Zeiss tripod (non-magnetic).
– Solar filter for sunshots.

Based upon past experience in measuring at repeat stations, the procedures for the Macedonian network were refined. We opted for geodetic azimuth measurements by sunshots. Measurements were done in early morning and/or late afternoon, because these times favour elimination of the daily variation differential between the station and observatory used for the reduction.

A preliminary proton magnetometer survey was performed before occupying each station to check the magnitude of the horizontal and vertical gradients to rule out magnetic pollution at the site.

The standard Diflux 12 step session (protocol): 2 × target, 4 × *D*, 2 × targets, 4 × *I* was used. This protocol is very strict and eliminatesalmost all Diflux and theodolite dimensional and mechanical errors.

After all performed measurements on every repeat station, the reduction technique (Delipetrev, et al., 2007) was performed and obtained the results for the elements of the geomagnetic field.

CONCLUSION

Repeat stations are permanently marked sites where it is possible to make accurate observations of the Earth's magnetic field vector for a period of a few hours (sometimes a few days) every few years. Their main purpose is to track secular variation and, if accurate observational techniques and careful reduction procedures are followed, they can be a way of supplementing observatory data for secular-variation modeling (Macmillan, 2007).

The magnetic repeat station has to be located in a magnetically undisturbed place, far away from electric railway lines, electric power lines, factories and other sources of magnetic disturbances.

The magnetic gradient at the chosen site should be less than 3 nT/m.

The site of observations should be marked (stabilized) with a permanent nonmagnetic marker. (There are several more or less complicated ways to do this: Sometimes geodetic markers might be directly used, a concrete slab or actual pillar can be installed, or you may just put a nonmagnetic aluminum nail in the ground. Just make sure you and anyone using your description will be able to find the marker again.).

At least two azimuth reference marks should be chosen more or less perpendicular to each other at a distance of at least 200 meters from the site.

A detailed topographic description of the site and reference marks should be made, as well as a description of the access to the site. Photographs can help, too. The determination of the geographical coordinates and elevation using a topographic map and/or GPS technique is also necessary.

The station should be named with a name recognizable on the topographic map (Newitt et al., 1996).

This procedure is necessary to ensure that even after some decades the site can be found by the next observers and the measurements will be performed exactly in the same place as previously. In case the station has to be moved to another site, the whole procedure described above should be done from the beginning. The name of the station can stay the same but has to be distinguishable by adding consecutive numbers, roman numbers or letters.

In the Republic of Kosovo, are planned to be established about 10 repeat stations which will meet the requirements of INTERMAGNET. On these points will be periodically measure geomagnetic field elements and appropriate maps, for all elements, will be create.

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Р е з и м е

ДЕФИНИРАЊЕ НА МРЕЖА ГЕОМАГНЕТНИ МЕРНИ СТАНИЦИ ВО РЕПУБЛИКА КОСОВО

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Овој труд ги прикажува процедурите кои треба да се спроведат за дефинирање на мрежа мерни станици на територијата на Република Косово, според стандардите на ИНТЕРМАГНЕТ. За целосно следење на геомагнетното поле на даден простор е потребно да постојат основна мрежа на станици за периодично набљудување на полето и геомагнетна опсерваторија која перманентно ги мери временските промени на геомагнетното поле. За дефинирањето на коефициентите на зависност на геомагнетното поле од географската ширина и должина во дадена точка на определен простор (обично држава), покрај постоењето на геомагнетна опсерваторија која е реперна точка, потребна е релативно хомогена мрежа геомагнетни станици. За таа цел треба да се извршат детални теренски мерења за да се дефинира одреден број мерни точки кои ќе ја сочинуваат мрежата на мерните станици на територијата на Република Косово. Основната мрежа на геомагнетните станици служи за периодични мерења во тие точки во интервал од 3 до 5 години. За дадена епоха (период од пет години) може да се пресмета вредноста на која било компонента на геомагнетното поле за дадена точка која припаѓа на просторот (државата) што ја покрива геомагнетната опсерваторија со координати φ_0 и λ_0.