Identification of magnetic carriers of original and secondary NRM components recorded in Devonian sediments from Podolia, SW Ukraine

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Palaeozoic sediments are widespread in the west and southwest of the East-European platform. They are presented by carbonate-terrigenous rocks which thicknesses are increases westwards. The attention of geologists and paleontologists has been attracted for a long time to the Silurian — Lover Devonian sedimentary rocks because of quality of their exposure on the high and steep slopes of rivers and valleys, almost horizontal position, weak metamorphism and the abundance and breadth of fossils.

Most of paleomagnetic poles of Silurian and Devonian age published for the Russian Platform are coincident with the Late Palaeozoic part of the APWP. So, there is a suspicion that these poles are not well dated or are based on secondary magnetization. The Silurian-Devonian part of APWR is based mainly on extrapolation between best quality poles. Although apparently well defined, the Silurian-Devonian part lying close to the Carboniferous segment of the APWP needs verification by new reliable data, and the main problem is identification of magnetic carriers of NRN components recorded in Devonian red sediments.

New Paleomagnetic study of Devonian ferruginous sandstones and siltstones from Podolia revealed that the main direction was recorded during remagnetization in Permo — Carboniferous time. Thermal demagnetization of Natural Remanent Magnetization (NRM) showed that this component was carried by mineral with blocking temperature (T_b) about 600 °C. In several samples, at the end of demagnetization curves, besides this main component, we isolated Devonian direction with T_b close to the value of hematite (670—690 °C).

Thermomagnetic analysis giving decay curves of saturation remanence during heating SIRM(T) made for a whole rock gave T_b characteristic for hematite, but the presence of other minerals was not observed, especially mineral of $T_b\approx600$ °C was not seen. Heating to 700 °C did not change composition of magnetic minerals. Thermomagnetic analysis made for the strongest component of NRM is similar to its thermal demagnetization — the main carrier of NRM is mineral with $T_b\approx600$ °C. Intensity of NRM is about 1 % of SIRM intensity. It means that the main magnetic mineral observed on SIRM(T) curves — hematite — did not record any stable paleomagnetic direction. Comparison of hysteresis parameters of rock and AF demagnetization curves of NRM revealed that the magnetic grains which are the carriers of the main component of natural remanence are as hard as the grains of main mineral. Although their T_b is close to T_b of magnetite (≈600 °C) very high coercivity and remanence coercivity exclude magnetite or maghemite. The alternative is hematite with small content of titanium. Proper identification of this mineral has crucial significance for interpretation of NRM components. Regarding primary Devonian component found in some samples at the end of demagnetization curves we believe that it was recorded in small amount of hematite grains possibly of different origin then majority of hematite being the source of SIRM.

Petrologic studies based on scanning electron microscopy (SEM), wavelength dispersive spectroscopy (WDS) and X-ray diffraction (XRD) analysis revealed the presence of three main magnetic carriers:

1) detritic grains of hematite with small content of Ti — up to 3 % (size up to 100 μm),
2) authigenic, pure hematite crystals (1—2 μm size) occurring in the ferruginous cement of sandstones,

3) unidentified (Ti-hematite?) iron oxide, formed within the disintegrating detritic chlorite and biotite grains.

The detrital hematite (with small content of Ti) is a primary magnetic mineral contained inside the rock. This is a good candidate for being a carrier of the Devonian component of NRM. Unidentified iron oxides (Ti-hematite?) can be responsible for the Permo-Carboniferous remagnetization. Authigenic, pure hematite crystals (1—2 µm size) occurring in the ferruginous cement of sandstones are the main source of SIRM but majority of grains does not carry any stable component of NRM.

Lessons of recent strong earthquakes in the world for Ukraine

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Experience of catastrophic earthquakes that occurred one after another in Haiti (12/01/2010, with Mw=7.0) and in Chile (01/12/2010 with Mw=7.0), makes seismologists to re-evaluate their effects and to compare the situation with the seismic protection in these countries with the situation in Ukraine. Both earthquakes are confined to the powerful seismically active zone of the planet. Earthquake in Haiti occurred within a seismically active zone associated with the zone of collision of the Caribbean plate with the South America plate. An earthquake near Chile — with the feat of the Nazca plate under the South American continental plate [http://upload.wikimedia ..., 2010]. In both cases, the earthquake occurred in areas where strong seismic events is not uncommon, which made seismologists and leadership of both countries in advance to shape up for strong earthquakes.

Unfortunately, from a comparison of maps of general seismic zoning (GSZ) of the territory of Haiti [http://neic.usgs …, 2010] and maps of macroseismic manifestations of the 01/12/2010 earthquake [http://earthquake.usgs …, 2010], the intensity of seismic manifestations of the earthquake was, in fact, higher than predicted by seismologists to map of the Haiti GSZ. The level of projected acceleration of seismic vibrations on the map, which, with probability 90 % will not be exceeded over the next 50 years, corresponds to the average acceleration of seismic vibrations in the 7-balls earthquake. In fact, during the 12/01/2010 earthquake in the Port-au-Prince capital city of Haiti were observed 9 balls macroseismic effects (on 12 point scale). Clearly, projected onto the 7-ball impact homes and buildings could not remain 9-balls intact. As a result, the main shock and several hundreds of aftershocks have killed more than 280 thousand people, several million people lost their homes and jobs. According to the Inter-American Development Bank's the losses caused by the earthquake could reach 14 billion dollars [http://www.rbc.ua/rus …, 2010]. In addition, the experience of similar past disasters is well known that after their income level of the population is reduced on average by 30 %, despite the assistance provided by the international community.

The earthquake near the coast of Chile, was much more powerful, but according to official information, the number of his victims was much lower (780 person), primarily because the country for many years considerable attention devote for earthquake-protection design and construction, as well as for the protection from tsunamis. Especially intensive, this work is carried out after the 22/05/1960 quake with Mw=9.5, which is considered as the strongest since 1900, when the registration of seismic events in the world have been widely used the instrumental techniques.

Comparison of the earthquakes effects in Haiti and Venezuela shows the importance of properly assessing the level of Seismic risk of the sites of existing and planned buildings and structures. Adopted at this time in the world the concept of seismic protection includes the need for protection from earthquakes by each investor, owner and developer who are building houses and industrial buildings in seismic zones. At the same time, it should be noted that self-investors, owners and developers are unable to obtain the seismological information about the magnitude of the parameters of the maximum seismic effects, which with a given probability of exceeding can be realized at the site of the existing or projected development, and is needed for its seismic protection. This task must be decided by the State.