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PRELIMINARY DATA ON THE CONNECTION OF THE CA. 150 MA LIPS WITH THE BAZHENOV FORMATION (WESTERN SIBERIA)

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Introduction

During the Phanerozoic eon, there are periods of oceanic ecological crisis (Ernst et al., 2017; Jenkyns, 2010; Kerr, 1998; Meyer et al., 2008), the so-called Oceanic Anoxic Events (OAE), which are characterized by low oxygen content or its complete absence in the surface and bottom layers of the waters of the sedimentation basins. The appearance of OAEs is associated with the activity of the LIPs (Jones et al., 2016; Self et al., 2015) and is determined by three main parameters: the volume of gas release, its composition (H_2O, CO_2, CH_4, SO_2, and halogens) and the height of the gas ejection. The larger the event, the greater the climatic and the environmental change. It is noted in the work of Wignall (2001), that perhaps the duration of short-term impulses that extend up to single volcanic streams is more important than the overall volume of LIP volcanism.

OAEs are clearly identified by the accumulation of black shale strata that emphasize reductive, oxygenless environments (Kerr, 1998). Except for the fundamental aspect, black shale is connected with a practical one — their oil and gas potential.

Almost every manifestation of black shale in the Phanerozoic eon is comparable to the activity of the LIP (Jenkyns, 2010; Ernst and Youbi, 2017; Zhang et al., 2018). Kimmeridgian oil and gas fields aged 155-146 Ma (Kerr, 1998) haves an age correlation with the Sorachi plateau in the western Pacific ocean (Kimura et al., 1994), the Shatsky Rise (Ernst et al., 2017; Heydolph et al., 2014; Sager et al., 2013), and the NW Australian margin event (Rohrman, 2013; Ernst, 2014).

The Bazhenov suite was formed in the close age range (152-145 million years ago) in Western Siberia, which suggests a connection with the above described events. The suite is a group of oil-source rocks composed of carbonate, clay and siliceous formations. The object of the study was the hydrocarbon deposit of the Krasnoleninsky arch (Khanty-Mansiysk). Within the deposit, sediments of the Bazhenov suite were sampled by 4 wells up to 40 m.

The main research methods were petrography (210 samples), XRF (414 samples) and XRD (414 samples). Analytical work was carried out in the Geodynamics and Geochronology Laboratory of Tomsk State University.

Results

According to the results of the multi-disciplinary studies, a four-member structure of the Bazhenov suite was established. The boundaries between the members were identified by significant changes in the physical and chemical parameters of the sedimentation basin waters. Each of the identified cycles (packs) is characterized by clear divides and is emphasized by the identified petrographic, mineralogical and petrochemical associations.

The base of the section is composed of siliceous-clay and carbonate-clay-silica rocks (1st pack), which are characterized by mineralogical (clay-quartz, carbonate-clay-quartz associations with minor pyrite contents) and petrochemical (aluminum-silicon and calcium-aluminum-silicon) associations. The formation of this section fragment took place in normal sea conditions in the outlying shelf environments.

The second pack is composed of clay-siliceous rocks with thin carbonate interlayers (clay-quartz and aluminum-silicon associations). The divide between the first and second packs is clearly traced by the appearance of barite, ichthyodetrite interlayer (local peaks of phosphorus oxide content) and a tuff layer in the section. These signs indicate the activity of the LIPs. This is expressed in the flow of sulfur dioxide (sulphate minerals) and carbon in the marine basin. The changes in the chemistry of the basin waters led to the decrease of various forms of life, and as a result ichthiodetrite accumulations were formed (mass death). Thus, the formation of the second pack took place under the conditions of the shelf zone in the basin, saturated with sulfur oxide and carbon, due to the activity of LIPs.

The third pack is represented by carbonate-clay-siliceous rocks and clay dolomites (calcite-clay-quartz and calcium-aluminum-silicon associations). The divide of the third pack corresponds to the appearance in the sections of the thick carbonate layer, which has at predominant calcite composition. Massive and abrupt precipitation of carbonate minerals is caused by strong contamination of the basin waters by carbon dioxide. Sulfate minerals are also noted, this may show that the SO_2 content abruptly increases in the environment of sedimentation. An increase of these gases content in water may be a consequence of active volcanic activity (Brand et al., 2015; Ernst and Youbi, 2017; Ganino et al., 2010). Also significant concentrations of ichthyodetritis are often associated with sections of sulphates, which indicates the mass death of marine organisms (Ernst and Youbi, 2017). Thus, a change in pH and Eh of water mode may be the result of significant climate change due to the activity of LIPs. After the formation of the carbonate pack is completed, a reduction of the acid-base and redox balance (short-term) of the sedimentation basin water is noted. During this period, normal-marine clay-siliceous rocks accumulate again.

The upper part of the suite (4th pack) is represented mainly by clay-siliceous rocks with a high content of organic matter and pyrite (pyrite-clay-quartz and sulfur-iron-aluminum-silicon associations). This indicates anoxic sedimentation conditions with a significant enrichment of organic matter (possibly increasing the concentration of CH_4 in the waters) and with significant hydrogen sulfide contamination (the flow of SO_2 and H_2S) (Brand et al., 2015; Ernst and Youbi, 2017). The divide separating the third and fourth packs is determined by the layer containing the fragments of andesites. The combination of the facts of the presence of a volcanic layer and the strong reducing conditions of formation make it possible to quite clearly recognize the activity of LIPs at this time.

Conclusion

On the basis of the conducted studies, direct signs of volcanic activity were established — tuff interlayers and layers with andesitic fragments. Given the significant stratigraphic dissociation of these finds in the section, it is assumed that the activity of LIPs was of a pulsating nature. Another variant is the existence of several LIPs in the time of Bazhenov suite formation, which is emphasized by the various conditions of the formation of the selected packs.

Thus, it can be concluded that at the time of the Bazhenov suite the active LIP has existed (possibly the Sorachi (Kimura et al., 1994), Shatsky Rise (Sager et al., 2013; Heydolph et al., 2014; Ernst et al., 2017), Okhotsk (Bogdanov et al., 2002), Magellan Rise (Ernst and Youbi, 2017), Southeast African (Gohl et al., 2011), NW Australian Margin (Rohrman, 2013; Ernst, 2014), which had a strong effect on the lower and upper layers of the atmosphere (The Okhotsk and Magellan Rises, both being oceanic LIPs would also have a direct effect on ocean water compoisition), which resulted in climate change and, as a result, physical and chemical parameters of sedimentation basin, which is reflected in the accumulated sediment.

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