

Formation Mechanism of Reduction Spheroids with Dark Cores in Cretaceous Red Beds in Jiaolai Basin, China

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Abstract

Red beds are not entirely red sometimes, in which grey-green spheroids or irregular spots can be found. However, the formation mechanism of grey-green spheroids or irregular spots in red beds is not clear so far. Samples taken from well JK1 in Jiaozhou area of Jiaolai Basin displayed that the reduction spheroids have more Vanadium (V) element, less TFe_3O_4 and Lead (Pb) element, almost the same content of other elements such as FeO and so on, comparing the red parts of the samples. The existence of organisms can explain the existence of green reductive spheres in the red beds formed under the oxidation environment.

Keywords

Red Beds, Reduction Spheroids, Formation Mechanism, Jiaolai Basin, Eastern China

1. Introduction

Color is one of the most important physical indicators of sedimentary rocks, which can be used for dividing rock types, stratigraphic division, analyzing palaeogeographic climate and sedimentary redox state and so on. It also has high landscape values. Red beds have attracted many scholars' attention for the bright color.

Red beds are not entirely red sometimes, in which grey-green spheroids or irregular spots can be found. Green reduction spheroids with dark cores containing enrichments of tellurium (Te) and selenium are found in red beds sediments from Mesoproterozoic successions [1]. There are similar geological phenomena in the Baikouquan Formation of the Mahu depression [2], the Lower Cretaceous Liwaxia Formation in Liupanshan [3], the Cretaceous Heshangpu Formation in Kongtongshan [4], and the Hongtuya Formation of Jiaolai Basin in China. Although the different explanations are given by the researchers, there is a conclusion that red represents the oxidizing environment while green represents the reducing environment. Samples from red beds in Jiaolai Basin were studied in order to ascertain formation mechanism of reduction spheroids in red beds.

2. Materials and Methods

Samples were taken from well JK1 in Jiaozhou area of Jiaolai Basin, which is scientific drilling with 664.7 m depth carried out by Shandong Institute of Geological Survey and Institute of Geology, Chinese Academy of Geological Sciences. K/Pg boundary has been emphatically studied and was determined at 537.4 m depth in JK1 [5]. One sample in red beds with 593.2 m depth has reduction spheroids with dark core clearly (Figure 1). The samples are observed under stereoscope and polarizing microscope, and analyzed the content of major and trace element in Analytical Laboratory Beijing Research Institute of Uranium Geology.

3. Result

Either red or green of the samples contacting mutative with no transitional color are original color instead of secondary color under the microscope, because the chromogenic minerals exist in the form of cements. The debris grains are mainly quartz. The red parts of the sample have almost same minerals with the reduction spheroids except the chromogenic minerals, which are confirmed by the microscopic photographs and XRD analysis results. The reduction spheroids have more Vanadium (V) element, less TFe_3O_4 and Lead (Pb) element, almost the same content of other elements such as FeO and so on, comparing the red parts of the samples, according to the analysis results of principal and trace elements. Further, the dark cores have obvious abundant V element comparing the rest area of reduction spheroids due to the electron probe analysis.

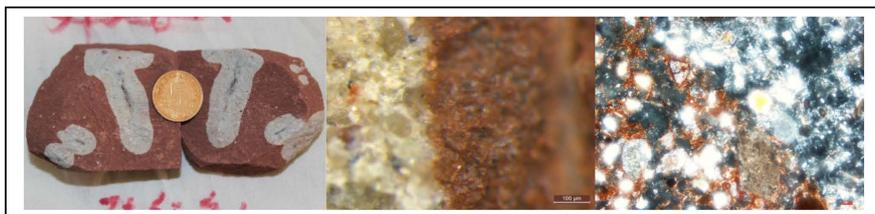


Figure 1. Different scale pictures of sample with 593.2 m depth from well JK1.

4. Discussion

Oxygen penetration into the subsurface, where spheroids develop, would have been relatively shallow, promoting redox boundaries [1]. Formation mechanism of reduction spheroids in red beds from the Baikouquan Formation of Mahu depression is that iron oxide is reduced by osmotic water, leaving a faded light green-gray spot after reduction [2]. Green interbeds in red beds from the Liwaxia Formation of Liupanshan called zebra mudstones, reflect the changes of redox environment. Taken together, reduction spheroids in red beds reflect the limited reduction in oxidizing environment. What is most important is that whether reduction or oxidization happened first.

The samples from red beds of Jiaolai Basin indicated that the distribution of reducing spheres in red beds is irregular, which illustrated that osmotic water generating green reduction spheroids is small probability event. Oxygen penetration into the subsurface, where spheroids develop, can't explain the large scales of red beds (>2000 m thick). However, abundant Vanadium which was an element of atypical biological significance has been found in sea water, sea urchins and other marine organisms, magnetite, asphalt minerals and coal ash [6] [7] [8]. In this way, it was inferred that reduction spheroids with dark cores in red beds are symbols of biological remains or activities, in other words, the dark cores may be fossils. However, we can't decide the biological species so far.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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