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Metallic Iron in Basalts of the Malyi Yenisei Lava River: Results of Thermomagnetic Study

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Abstract—Thermomagnetic analysis of samples from two sections of lava layers of the Late Cenozoic basalt lava river in the Malyi Yenisei valley is carried out. The main magnetization carrier in the studied basalts is titanomagnetite with the Curie points of 100–120°C which is frequently substantially oxidized both single-phase and heterophase up to magnetite. It is likely that some part of metallic iron in the studied samples has also been oxidized and even disintegrated, which resulted in the significant scatter of iron concentration across the flow against which, however, the increasing trend of iron concentration in the lava flow from the top downwards is observed. The relative magnitude of this increase (iron concentration gradient along the vertical of the lava flow) is almost constant for all flows of the lava sequence probably indicating the decisive role of gravity in iron particle precipitation in the lava. Based on the synthesis of iron particle data from different objects and different regions of the world, this correlation with gravity also follows from the very similar shapes of particle size histograms of iron. This is most clearly seen from the same particle size modes (10–20 μm). Another important finding is that this constant mode of iron particle size does not depend on age and origin of rock as well as on the type of particle source (terrestrial or extraterrestrial).

Keywords: metallic iron, titanomagnetite, thermomagnetic analysis, gravitational precipitation

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INTRODUCTION

Previously (Pechersky et al., 2018), the thermomagnetic study of basalts of Zhom-Bolok lava river, East Sayan, revealed a fairly natural although not quite obvious phenomenon: relatively heavy particles of metallic iron precipitate in liquid lava melt, which was confirmed by the detected increase in iron content from top to bottom in the lava flow. The average iron concentration over a series of sections of the Zhom-Bolok lava river in the lower part of the flows is several times higher than that in the upper part.

The composite diagram of iron content distribution along the vertical section of four Zhom-Bolok lava flows, which is presented in Fig. 1a, shows that despite wide scatter of the data, a quite distinct trend of iron concentration increasing from top to bottom is observed. A more visual picture of the changes in iron concentration along the vertical section of flows can be seen from the comparison of average iron concentrations in three parts of the section of flows—in the upper, middle, and lower ones(Fig. 1b).

In our opinion, the result obtained in (Pechersky et al., 2018) (Fig. 1) is definitely of interest to geophysics as it is likely to testify to the decisive role of Earth's gravity in the deposition of iron particles in a liquid basalt lava.

However, it should be noted that the number of basalt samples of Zhom-Bolok lava river selected from each flow was overall rather limited: two or three samples were taken from each flow (at the top, middle, and bottom). Therefore, the obtained results needed to be validated based on a more representative collection of basalt samples.

This work addresses the thermomagnetic study of metallic iron in basalt samples from the lava river of Malyi Yenisei.

STUDY OBJECT

The lava river of the Malyi Yenisei valley (Kaa-Khem and Kyzyl-Khem) is the largest Late Cenozoic valley lava flow of South Baikalian volcanic area of Central Asia (Yarmolyuk et al., 2004; 2015). Its length