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Revealing the magnetic mineralogy of thick lava flows

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The remanent magnetization of basaltic rocks is complicated, depending on factors including the chemistry of the magma, its cooling rate, external magnetic field and oxygen fugacity. In thick lava flows, some of the affecting parameters are constant while others vary in a systematic way, allowing detailed study of the magnetic properties of the rocks.

Here we present the results of a combined remanence/Mössbauer study of a 5.5 m thick basalt flow from Hrútagjárdyngja (HD) in SE Iceland. The findings are compared to similar findings from the Roza flow field (Columbia River Basalt) [1].

Mössbauer spectroscopy is an ideal method for characterizing the magnetic mineralogy in basalt [2], and here it is illustrated how the method can yield quantitative information on the iron-oxide mineralogy, oxidation processes, and indirectly the magnetic properties.

In the Roza samples, the Mössbauer spectra reveal the magnetic phase as titanomagnetite (Ti-Mt; $Fe_{3-x}Ti_xO_4$). In the bottom part of the flow, the value of x is determined to be ~ 0.6, gradually increasing toward the top due to higher oxidation state and slower cooling rate.

In the HD samples, this picture is slightly different due to oxidation of the iron in olivine to pure magnetite and hematite both in the bottom part and the top part. It is discussed how this has affected the remanence.

[1] Audunsson, H., Levi, S., Hodges, F.: Magnetic property zonation in a thick lava flow. J. Geophys. Res. 97, 4349–4360 (1992)

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