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What do variable magnetic fabrics in gabbros of the Oman ophiolite reveal about lower oceanic crustal magmatism at fast spreading ridges?

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The magmatic processes responsible for accretion of the lower oceanic crust remain one of the least constrained components of the global seafloor spreading system. Samples of gabbroic rocks recovered by scientific ocean drilling are too limited to allow effective assessment of spatial variations in magmatic flow within in situ lower crust. Extensive exposures of gabbros in ophiolites, on the other hand, provide opportunities to study accretion processes in three-dimensions across wide areas and at a resolution that allows variations in magmatic fabrics through the crust to be quantified. Here we show that magnetic anisotropy provides a reliable proxy for lower crustal magmatic fabrics in the world's largest ophiolite in Oman. Important differences in magnetic fabrics are detected that reflect variations in magmatic processes on a range of scales. Fabrics in layered gabbros are aligned with modal layering and display a consistency in the orientation of maximum principal axes of anisotropy between localities at a regional scale. These fabrics are compatible with subhorizontal preferred alignment of crystals, orthogonal to the inferred orientation of the Oman spreading axis, resulting from magmatic flow or deformation of melt-rich crystal mushes during spreading. In contrast, magnetic anisotropy in foliated gabbros at the top of the lower crust reveals for the first time distinctly different linear and anastomosing fabric styles between localities sampled at the same pseudostratigraphic level. These differences reflect spatial variations in the style and trajectory of flow in the crystal mush beneath the axial melt lens during upwards melt migration at the spreading axis.