

## Dynamics of pillow-dominated subglacial eruptions recorded in Undirhlíðar quarry, Reykjanes Peninsula, southwest Iceland

Meagen Pollock<sup>1</sup>, Benjamin R Edwards<sup>2</sup>, Lindsey Bowman<sup>1</sup>, Ellen Was<sup>2</sup>, Rebecca Alcorn<sup>1</sup>, Steinunn Hauksdottir<sup>3</sup>

<sup>1</sup>The College of Wooster, USA, <sup>2</sup>Dickinson College, USA, <sup>3</sup>ISOR, Iceland

E-mail: mpollock@wooster.edu

The dynamics of pillow-dominated subglacial eruptions have been investigated in Undirhlíðar quarry, southwest Iceland, which exposes an almost complete cross-section of a subglacial pillow ridge. Quarry walls are dominated by pillow basalts ranging in size from 0.5 m to 3 m in diameter. Two stratigraphically and lithologically distinct lenses of volcanic tuff-breccia are interbedded with pillow lava units in the eastern half of the quarry. One of the units, comprising a poorly sorted range of clasts, appears to be made predominantly of broken fragments of pillow lava. The other unit shows somewhat better sorting and has clasts with intact vitric rims, interpreted to be volcanic bombs. Thin (<30 cm) laterally continuous layers of indurated yellow vitric lapilli tuff separate some pillow units. Three dikes have been observed, at least one of which feeds an overlying pillow unit. The Undirhlíðar units define two mineralogical and chemical populations: (1) incompatible element enriched (Nb/Zr ~0.15) rocks comprising the olivine-free lower (older) pillow units, and (2) less enriched (Nb/Zr ~0.125) units including the olivine-phyric dikes, west wall pillows, and the upper (younger) pillow units. The combined lithostratigraphic, petrographic, and geochemical relationships suggest a 4-stage emplacement model. (Stage 1) An initial effusive phase erupts the incompatible element enriched, olivine-free pillow lavas, building the bulk of the subglacial ridge. (Stage 2) An explosive phase generates the lens of tuff-breccia on the eastern side of the ridge. (Stage 3) A second effusive phase on the west side of the quarry intrudes the initial effusive deposits and erupts pillow lavas that drape over the western edge of the existing ridge. This effusive phase is distinguished from the first as a distinctly olivine-bearing batch of magma less enriched in incompatible elements. (Stage 4) A final effusion on the east side of the quarry intrudes tuff-breccia formed by partial collapse of a pre-existing pillow unit, and erupts a capping layer of pillow lavas. This effusion is compositionally similar to the previous effusive phase (Stage 3), but large olivine phenocrysts are absent. Our model for the formation of Undirhlíðar adds to the observations of previous workers by documenting two important relationships: (1) the specific stratigraphic sequence of vitric tuff-breccia cut by dikes that feed pillow lava flows emplaced immediately above the tuff-breccias (TDP lithofacies association), and (2) the chemical transition that coincides with the TDP lithofacies association from olivine-free incompatible element enriched rocks to olivine-bearing rocks that are less enriched in incompatible elements. These observations suggest that explosive volcanism may play an important role in pillow-dominated subglacial eruptions, and that the formation of subglacial pillow ridges can record complex magma supply dynamics.