Inter-lava sedimentation and siliciclastic reservoir potential, mid-Norway: IODP site U1566

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International Ocean Discovery Program (IODP) Expedition 396 drilled 21 holes at 10 sites spanning the mid-Norwegian volcanic rifted margin in 2021. In the northwestern part of the Møre Margin Site U1566 penetrated the western flank of the Kolga High, close to the continent-ocean boundary. Hole U1566A penetrated a ~120 m Seaward Dipping Reflector (SDR) sequence beneath a thin Quaternary sediment cover. Coring revealed a basaltic lava flow dominated sequence with inter-layered volcaniclastic and siliciclastic sediments, the latter containing granitic clasts eroded from the nearby high. The base of the volcanic sequence was recovered in the cores and marks a sharp transition from sub-aerial lava flows into deeply altered and weathered granite. Approximately 27 m of granite was recovered which includes multiple granite-derived sandstone stringers of variable orientation, a feature attributed to infill of a deep sub-aerial weathering profile in the granite.

A comprehensive suite of shipboard petrophysical and wireline data were collected in order to characterize the SDR sequence including whole-Round Multi-sensor Logger measurements, P-wave caliper and point magnetic measurements on working-half core sections, plus 102 discrete sample measurements for porosity and density. In addition, ambient permeabilities were measured on 30 minicore samples along with petrography and SEM imaging. Wireline data including gamma, density, P- and S-wave velocity, resistivity, magnetic susceptibility, and image log data (micro-resistivity and acoustic) were collected over the main volcano-sedimentary sequence along with VSP.

Facies analyses of the volcanic sequence reveals a mixture of pahoehoe, transitional and aa lava flow lobes rarely exceeding ~3 m in thickness. Despite porosity exceeding 40 % for some lava flow margin samples, matrix permeability rarely exceeds a few 10's of millidarcies and is linked to alteration and pore clogging by secondary minerals. These findings highlight the requirement for fracture contributions to fluid flow in order to achieve useable reservoir potential in the post-erosion preserved lava flow sequence at this and similar sites. Fifteen sedimentary interbeds were recovered ranging from c. 1 cm up to 2.6 m in thickness with an average thickness of c. 66 cm. Nine of the interbeds are dominated by siliciclastic sediments derived from the Kolga granite with an average thickness of c. 83 cm. Mini-core samples of siliciclastic inter-layers spanning the volcanic and granitic sequence reveal average porosities of c. 30 % with permeabilities up to 430 millidarcies highlighting potentially good reservoir potential within the area.

Results from site U1566 reveal unique insights into the formation of SDRs on the mid-Norway margin revealing that the Kolga High is capped by a granite which was rapidly eroded and exposed sub-aerially during pre-, syn- and post-SDR development. In addition, the site provides the first evidence for coarse grained siliciclastic sedimentation during SDR eruptions as continental breakup progressed. This highlights the possibilities for inter-lava reservoir potential mid-Norway. The results also highlight the requirement for new drilling to bring understanding of this complex area forward.