Petrophysical and mineralogical characterization of IDDP-2 mini-core samples from depths of 3650 to 4650 m

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As part of the exploration of supercritical geothermal reservoirs at the Reykjanes Peninsula, SW Iceland, the IDDP-2 consortium have accomplished a series of exploratory drillings and coring in order to investigate the physical conditions at depths of 4-5 km, governed by high temperature-high pressure environments. A set of 13 centimetric cylindrical mini-cores samples extracted from cores drilled at depths from 3638 m to 4654 m were studied to identify their alteration mineralogy and related physical properties. Optical and SEM observations on thin sections indicate that samples are medium to fine grained diabase intrusions showing granular holocrystalline textures. Composition from XRD on powders and combined EDS/EBSD analysis on a SEM indicate that the rocks are mostly composed of plagioclase and hornblende, which replaces primary augite phenocrysts (80 to 90% of rock composition). Unaltered augite phenocrysts are almost absent within the shallower sample (2%<), but became more abundant downwards (5-15%). Accessory minerals found are magnetite, ilmenite, enstatite and secondary quartz and biotite, which are more abundant at the lowest depth (5%). The primary alteration is replacement of pyroxene by hornblende with low amounts of epidote in the shallowest samples and biotite in the deepest samples. EBSD analysis performed on a SEM on 6 samples did not display any crystal preferred orientation, indicating that the samples should be isotropic at depth. Petrophysical properties such as porosity, acoustic velocity (Vp-Vs) and electrical conductivity were measured on all the samples at room conditions in dry and saturated conditions. All the samples show low porosity, ranging from 1 to 4%. Macroscopic observations as well as SEM observations indicate that the porous network is principally due to open – non mineralized- fractures developed during drilling operation under the combined effects of drastic cooling and decompression. These effects are stronger as depth increases. On some samples, principally at deeper depth, intergranular, equant micropores are also present. P-wave velocities under dry conditions range from 4 to 6 km/s at depths intervals of 3650 to 4300 m and are only 2.5 km/s at higher depths (4640 m - 4653 m). Under saturated conditions p-waves velocities increase by about 1 to 1.5 km/s. Samples with the smallest grain-size have the lowest porosity as well as the highest velocities. This preliminary characterization indicates that microfracturing of the rock induced by drilling operations has a strong influence on the physical properties of reservoir rocks, in particular at deeper depth. Further investigations are planned in order to examine the effect on the physical properties of the reservoir rocks of the fracture reduction or enhancement under varying conditions of temperature and pressure.

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