Expanding a Geothermal Field Downwards. The Challenge of Drilling a Deep Well in the Hengill Area, SW Iceland.

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In 1986 a well, which was planned as a conventional production well in the Nesjavellir Field in the Hengill Area, SW Iceland, was unexpectedly drilled into a very hot formation at the depth of 2.1 km. The measured temperature in the lowest part of the well was 380°C, which was the upper range of the measuring tool used. Thus, the bottom-hole temperature was most probably higher. No one expected to hit such a hot body in this place and the well design was not appropriate to handle such high temperatures and resulting pressures. Thus, the lower parts of that well were closed off and it has since then been operated as a conventional geothermal well.

This incidence sparked the idea of drilling deeper into volcanic hydrothermal systems in Iceland in order to gain a better understanding of the roots of the geothermal systems and to be able to produce fluids with higher enthalpy. The Iceland Deep Drilling Project (IDDP) is supposed to realize that idea. The IDDP project is a consortium of domestic and international partners, both from industry and academia. The three power companies in Iceland, which operate power-production in volcanic geothermal fields (Landsvirkjun, HS-Orka, OR), committed themselves to drill one deep well each in a field of theirs.

To date two wells have been drilled in the IDDP project. The first one, IDDP-1, was drilled in the Krafla Field, N Iceland, which is operated by Landsvirkjun, and the second well, IDDP-2, was drilled in the Reykjanes Field, which is operated by HS-Orka. The original plan was to drill down to 4-5 km. However, the IDDP-1 in Krafla was drilled into magma of rhyolite composition at the depth of 2.1 km and could therefore not be drilled further. During flow tests, it was flowing superheated steam at high pressure at well head temperature of 450°C. The power capacity was estimated to be 36 MWₑ. However, due to hostile chemistry of the fluid and damaged casing, the well had to be abandoned and closed after the well tests. IDDP-2 was drilled down to 4,659 m. The highest temperature measured in the bottom of the well was 426°C at a pressure of 340 bar. It was also possible to obtain core samples from the bottom of the well. However, due to damaged casing it hasn’t been possible to do further temperature and pressure measurements in the lower parts of IDDP-2. To date flow tests in IDDP-2 have not started.

The next well in the IDDP project is planned in the Hengill Area. The most promising target is the hot body that started it all in the Nesjavellir Field. According to experience from IDDP-1 and IDDP-2
the main technical obstacle is the casing. Both wells have serious casing problems. The magma body unexpectedly hit by IDDP-1 illustrated that careful interdisciplinary preparations are needed when drilling into the unknown. Currently, few projects are ongoing to fill the knowledge gaps in order to minimize risk and maximize the probability of successful drilling.