# A characterization of the aquifer system near the Hellisheiði geothermal plant in south-eastern Iceland, using noble and other gas tracers

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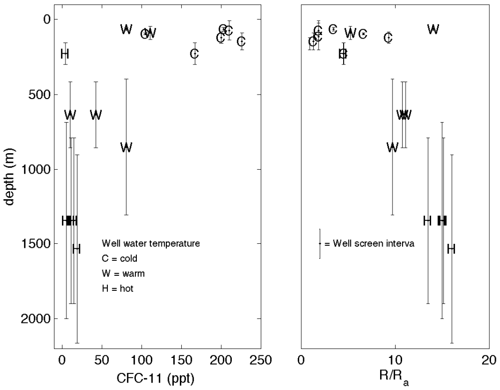
The utility provider for Reykjavik, Iceland (Orkuveita Reykjavikur) has set forth the goal of capturing and sequestering carbon dioxide that is liberated by pumping hydrothermal fluid to the surface for power production (www.carbfix.com). The intent is to use both solubility trapping and mineral carbonation to provide stable $CO_2$ storage by re-injecting the $CO_2$ effluent at a depth where the water temperature is high enough to enhance the kinetics of mineral dissolution, but without entering a thermal regime where significant gas-liquid phase partitioning is a concern. During the design phase, it was determined that $SF_6$ would be used to trace the re-injected effluent and so a baseline characterization of the groundwater was necessary. Here we present measurements of He ($^3He$ and $^4He$), Ne, Ar, Kr and Xe, $SF_6$, CFC-11 and CFC-12 as geochemical tracers of mixing and transient tracers of groundwater age. The measured $^3He/^4He$ ratio (R) divided by the atmospheric $^3He/^4He$ ($R_a$) and the concentration of CFC-11 predictably decreased with depth. $R/R_a$ exhibits a remarkably linear mixing trend between mantle helium ($R/R_a \sim 15$) and atmospheric helium ($R/R_a = 1$). The concentration of $SF_6$ ranged between 0 and atmospheric concentration (~ 6.5 parts per trillion (ppt)) at cold and warm wells. $SF_6$ is used to make enthalpy estimates at geothermal wells and concentrations up 8.5 ppt were observed. Using the noble gases we determine the excess air contribution and the recharge temperature. By applying these corrections to the CFCs, the mean tracer age is less than 25 years for the aquifer depths above 500 m. Below 1000 m in the geothermal system, the CFC's also indicate a relatively young water mass, but boiling and gas-liquid phase partitioning in the well shaft leave this estimate poorly constrained.



# Geochemistry of stream waters from an abandoned Sn-W mine area, northeast Portugal

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The Mina da Ribeira mining site, is an abandoned Sn-W mine located in the northeast region of Portugal. The mine works took place on the northern side of the Viveiros stream valley, which is an affluent of the Sabor River (1 km away from the mine site). The mineralized quartz veins contain cassiterite + wolframite + scheelite + arsenopyrite + pyrite + sphalerite + chalcopyrite + manganocolumbite + bismuthinite. The rejected materials and tailings were deposited on the hillside and are nowadays exposed to significant weathering and erosion. The eroded material is carried away, along the Viveiros stream. Water samples from the Viveiros stream, Sabor River and tailings seasonal water drainages were collected.

The results show sodium bicarbonated to calcium sulphated waters, under maximum tailings influence. The sulphate water content is low (up to 144.7 $mgl^{-1}$). The pH values are close to neutrality and the maximum conductivity is 359 $\mu Scm^{-1}$, so no acid mine drainage evidences were found. Most of the year, the dissolved mineral content is low on the Viveiros stream and Sabor River. The contents of Mn, Cu, Zn and Cd found on the tailings seasonal water drainages are higher than those found in the Viveiros stream and Sabor River. During summer the seasonal drainages are dry, and the Viveiros stream shows As, Cd and Pb contents (e.g. As 0.29, Cd 0.033 and Pb 0.55 $mgl^{-1}$), higher that those permitted by Portuguese law. In the Sabor River a clear decrease in concentrations can be noticed (e.g. Cd 0.012; Pb 0.003 and As 0.020 $mgl^{-1}$). The highest contents of Cd are associated with the highest contents of Zn; the highest contents of Mn, Cu, Zn and Cd are associated with the lowest contents of As and Fe; a correlation between sulphate and Zn-As was also found. These results point out to arsenopyrite and sphalerite dissolution and to iron oxy-hydroxide precipitation/As adsorption or co-precipitation as a sinkage mechanism for As. On the Eh-pH prevailing conditions, $Cd^{2+}$ is rather stable aqueous phase.