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Geothermal brines as mineral resource, new scopes beyond lithium extraction

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Geothermal fluids are used as sustainable, alternative energy source for electricity and heat generation in geothermal power plants. Two general settings are distinguished, using hot fluids in active volcanic regions or using lower temperature geothermal brines in sedimentary basins. It has long been known that the geothermal fluids in active volcanic areas are enriched in e.g., Au, As, Sb, Ag and Cu. In the 1980s, chemical and physical data from geothermal power plants in New Zealand have been used in order to develop genetic models for the formation of Au-Ag-(Cu) deposits, the so-called epithermal gold deposits. Geothermal basin brines, for example in the Upper Rhine Graben, have temperatures of ~90-300°C and often have high salinity (up to 40 wt.% total dissolved solids). Such high-salinity basin brines are able to transport divalent transition metals as chloride complexes and are involved in the formation of sedimentary rock-hosted mineral deposits, such as Mississippi Valley Type (Zn-Pb) and Kupferschiefer Type (Cu) deposits. Mining these deposits produces several important byproducts, such as Ag, Ga, Ge, In, Co, PGE and Te. We, thus regard geothermal brines not only as heat carriers but also as metal carriers in sedimentary basins.
It is now well known that some geothermal basin brines like in Cornwall (UK) or Salton Sea (USA) are enriched in Li and several lines of processing technologies for Li extraction are being developed and tested. Recently, several exploration licenses for Li extraction from geothermal brines have been granted in the Upper Rhine valley. Although the data set for geothermal brines from the Upper Rhine Graben is incomplete, some metals other than Li are recognized as enriched in the fluids, including Zn, Sb, Be, Cs, Ge and Rb. Such elements also have the potential for economic extraction from the produced geothermal brines.
Although Zn is an economically important metal and it is enriched in the brine, the geothermal fluids are not considered a promising Zn resource, because of the low annual extractable amount in comparison to the large-scale global production (13 Mt in 2018) from sulfide deposits. Antimony (fire-retardant chemicals), Be (extreme light-weight alloys), Cs (cell phone, GPS), Ge (fiber optics, solar cells, LED) belong to the so-called technology elements and are produced at much less volume or as byproducts of large volume commodities. Rubidium is very rare on the market with special applications in biomedical research, special glasses and electronics. Many of these elements are not mined in Europe at all. Thus, Europe and Germany are completely dependent on a free market and the possibility to import these raw materials. The large volume of fluids (ca. 30-100 l/s) passing through the various geothermal power plants in the Upper Rhine Graben grants a significant supply of geothermal fluid as a carrier of raw materials from deep sources to the surface. Technologies need to be developed to make this resource available to the society.

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