REE contents in minerals and water from hydrothermal veins

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More than 400 hydrothermal vein-type deposits form the Schwarzwald ore district, SW Germany. They consist of fluorite±barite±quarz±carbonate veins with various ore minerals. (Sub-)recent dissolution of primary minerals result in precipitation of secondary minerals such as agardite, rhabdophane, Fe/Mn oxides, secondary calcite, fluorite or barite, that bear heavy metals and/or REE.

In this work, primary and secondary minerals from a variety of veins in the Schwarzwald have been analysed by electron microprobe and LA-ICP-MS for their trace element composition, particularly with regard to their REE contents. In addition, water samples from some underground mines were analysed for their $\delta^{18}O$ values and for trace elements and REE by ICP-MS.

The results suggest various sources and processes during dissolution and precipitation of ore and gangue minerals:

1. Oxygen isotope ratios and REE data suggest a strong influence of meteoric water [1, 2] on the composition of the mine waters.
2. Some late calcite, fluorite and Fe-oxide samples show REE distributions similar to those of the mine waters, suggesting that only limited fractionation takes place during mineral precipitation.
3. Co-precipitation of secondary agardite ($REECu_6(AsO_4)_3OH_6 \cdot 3H_2O$) and Fe-oxide results in a separation of Ce^{4+} from Ce^{3+} which is displayed in a negative and positive Ce-anomaly in the two minerals, respectively.
4. Secondary REE minerals display REE distributions completely different from the mine waters, which indicate a further, more complex process of REE partitioning, probably governed by crystal-chemical effects.

From these results we conclude that there are multiple sources and sinks for REE. Complex dissolution-complexation-precipitation processes are responsible for their redistribution in hydrothermal veins.

[1] Schotterer *et al.* (1996) *GNIP - Global network for isotopes in precipitation*. IAEA: Vienna, 47pp. [2] Aubert *et al.* (2002) *Geochimica et Cosmochimica Acta* **66**, 3339-3350.

Dating late Holocene glacier advances with ^{10}Be: Enchantment Lakes Basin, Washington, USA

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Recent improvements in chemical and mass spectrometric techniques have opened new frontiers in the application of surface exposure dating, offering the possibility of mapping global glacier activity over the entire Holocene period as a basis for paleoclimate analysis. In particular improved analytical sensitivity has made it possible to date historical and late pre-historical moraines. We present the first ^{10}Be exposure dates of Little Ice Age and also of earlier moraines from the Cascade Range, Washington. The ability to date Little Ice Age moraines in the Cascades is particularly desirable because in this region lichenometry is of limited temporal application, dendrochronology can suffer from a prolonged ecesis period due to lack of moraine stabilization, and the historical record only begins at approximately 1900 AD. For this study fifteen boulder samples from moraines deposited by small alpine glaciers in the Enchantment Lakes Basin were sampled for ^{10}Be analysis. Resulting exposure ages range from ~ 100 yr to greater than 4000 yr, with the ages grouping around 100 yr, 500 yr, 900 yr, and 2100 yr bp. We tentatively interpret this grouping to indicate repeated reoccupation of the same moraines throughout the later Holocene. Our limited record agrees well with moraine age estimates from elsewhere in the Cascade Range and with records from the Swiss Alps, Greenland, and Patagonia. This work demonstrates that Little Ice Age moraines can successfully and precisely be dated in the Cascade Range, regardless of the high snowfall amounts.