Age resolution of polymetamorphic events in the Scottish Northern Highlands using Lu – Hf, Sm – Nd and Rb – Sr methods

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Previous age determinations of metamorphic events in the Scottish Northern Highlands have been limited in sample number and type of material. Here, we present new ages for peak metamorphism and cooling using Lu–Hf and Sm–Nd dating of garnets and Rb–Sr dating of micas. Garnets show wide variation between the Moine stratigraphic units and basement rocks. Garnets show marked MnO zoning, increasing from core to rim, with FeO showing the opposite trend. Garnet cores are relatively homogeneous and the rims are comparatively more heterogeneous with inclusions of zircon, apatite and monazite. HREE show a decrease from core to rim. The chemical differences correlate with textural changes within the garnets. We suggest this zoning has been developed during prograde deformation.

The southern areas have yielded garnet Lu–Hf ages between 828Ma and 903Ma which are 50Myr and 200Myr older than the Sm–Nd ages and represent Knoydartian metamorphism. In contrast, northern areas yielded significantly younger Lu–Hf ages of ~449Ma which are very similar to the Sm–Nd ages. Despite this evidence for rapid cooling, this age does not correspond with the published timing of either Grampian or Scandian metamorphic events. These ages provide information on the different tectonics in this terrane and could show that the northern area cooled much faster than the southern area, indicating faster exhumation. This is supported by further evidence from Rb-Sr dating of micas, which clearly show the contrast in ages between the southern and northern parts of the terrane.

Assessment of soils contamination in the areas influenced by the Narva Power Plants (Estonia)

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Balti and Eesti Power Plants (Narva PPs) are the largest in the world using oil shale for energy production. The annual electric and thermal production of the plants in 2007 was 12,6 mln kWh, comprising about 95% of total energy production in Estonia. Combustion of oil shale leads to generation annually up to 5-6 Mt of ash and emission of 4-11 thousand t of fly ash. Owing to small particle size and large specific surface emitted fly ash adsorbs trace elements and therefore it is a potential hazard for the environment. The complex geochemical investigation including low-scale geochemical mapping of topsoils in the area of approximately 300 km^2, soils and ashes leaching, ash composition studies was performed to evaluate potential hazards of contamination in Narva region. Concentrations of 43 chemical elements were measured by ICP-MS in topsoils and ashes digested in a 4-acid solution (HNO_3, $HClO_4$, HF and HCl).

Principal component analysis applied to separate geogenic and technogenous factors in elements accumulation in the soils showed significant differentiation in elements spatial distribution depending on lithology of underlying sediments.

Concentrations of majority of elements studied in the ashes sampled sequentially starting from coarser furnace ash up to finest fly ash from electrostatic precipitators from four power units of Narva PPs with different combustion technologies rapidly increased in the finest fractions and showed the most significant accumulation for Ag, As, Ba, Bi, Cr, Cs, Pb and V. The concentrations of As, Ni, Pb and Sr in the finest fractions of ashes exceed their means in arable soils of Northern Estonia more than three times and Co, Cr, Cu, Mo, Nb and V up to 2-3 times. Data statistical treatment revealed association of Ag, As, Cd, Mo and Zn with aluminosilicates in mineral part of ashes.