# Determination of lanthanoids and actinoids in rock salts

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## Summary

Lanthanoids (Ln's; $_{57}$La - $_{71}$Lu), thorium ($_{90}$Th) and uranium ($_{92}$U) in seven rock salts samples from Stassfurt, Germany, were determined by the neutron activation analysis (NAA). In the preparation of samples for neutron irradiation, incorporated was a coprecipitation process (aluminium coprecipitation) in which aluminium was used as a collector of Ln's, Th and U after dissolving the salt samples in dilute hydrochloric acid, in order to enhance concentrations of those elements and to reduce amounts of interfering nuclides in gamma-ray spectra in advance of neutron irradiation. Two kinds of neutron activation were attempted, *i.e.*, activation by thermal neutrons and activation by epithermal neutrons; the latter is effective for the detection of such nuclides as $^{152}$Sm and $^{238}$U whose resonance activation integrals are large.

Seven or eight elements out of fourteen naturally occurring Ln's (promethium does not occur in nature) were determined at sub ppb levels in the soluble-in-dilute hydrochloric acid parts (soluble parts) of the rock salt samples. Th and U were also determined at sub ppb levels in all the soluble parts. Among the fourteen Ln's, lanthanum, cerium, samarium and europium were determined in all the samples. Thus, they are elements suitable for the determination by NAA. Contrary to these elements, praseodymium (Pr), gadolinium (Gd), holmium (Ho) and erbium (Er) were not detected in any of the samples. The half lives of the Pr, Ho and Er nuclides used for the determination are relatively short, which is a reason for those elements being not detected by the present method. In order to determine Gd, it will be necessary to identify the interfering nuclide whose peak overlaps with that of the Gd nuclide in gamma-ray spectra and to correct for its amount. Although their concentrations were at sub ppm level, only a very small number of the target elements were determined for the insoluble-in dilute hydrochloric acid parts of the rock salt samples, for which the coprecipitation process was not adopted. This fact strongly suggests that the aluminium coprecipitation in the irradiation sample preparation is quite effective for the determination of Ln's, Th and U by NAA.

The lanthanoid abundance patterns (Ln patterns) of the rock salt samples obtained by normalization with the Ln contents of Leedey chondrites resembled each other as a whole, showing a relative enrichment of the light Ln's and negative slopes. They also resembled roughly the Ln pattern expected for the evaporated residue of seawater (Ers), although Ln contents of the rock salt samples were about ten times higher than that of Ers.