Er – Erbium

Introduction

See section on Rare Earth Elements (REE)

Table 26 compares the median concentrations of Er in the FOREGS samples and in some reference datasets.

Table 26. Median concentrations of Er in the FOREGS samples and in some reference data sets.

Erbium (Er)	*Origin – Source*	*Number of samples*	*Size fraction mm*	*Extraction*	*Median mg kg^{-1}*
Crust[1)]	Upper continental	n.a.	n.a.	Total	2.3
Subsoil	**FOREGS**	**790**	**<2.0**	**Total (ICP-MS)**	**2.18**
Topsoil	**FOREGS**	**843**	**<2.0**	**Total (ICP-MS)**	**1.98**
Soil[2)]	World	n.a.	n.a	Total	**2**
Water	**FOREGS**	**807**	**Filtered <0.45 µm**		**0.006 (µg l^{-1})**
Water[2)]	World	n.a.	n.a.		0.0042 (µg l^{-1})
Stream sediment	**FOREGS**	**848**	**<0.15**	**Total (XRF)**	**2.67**
Floodplain sediment	**FOREGS**	**743**	**<2.0**	**Total (XRF)**	**1.96**

[1)]Rudnick & Gao 2004, [2)]Ivanov 1996.

Er in soil

The median Er content is 2.18 mg kg^{-1} in subsoil and 1.98 mg kg^{-1} in topsoil; the range varies from <0.1 to 7.42 mg kg^{-1} in subsoil and from 0.12 to 26 mg kg^{-1} in topsoil. The average ratio topsoil/subsoil is 0.931.

Erbium in subsoil shows low values (<1.46 mg kg^{-1}) throughout central and northern Finland, the glacial drift area from Poland to the Netherlands, the Paris Basin in France, the western Alps and Rhône valley, central Hungary, central Portugal, southern Spain, part of east Spain, and part of east Greece.

High Er values in subsoil (>2.91 mg kg^{-1}) are located mainly on the crystalline basement of the Iberian Massif in northern Portugal and north-west Spain, in the Italian alkaline magmatic province, in soil on karst of Slovenia and Croatia, in southern Hungary and Austria, the loess/palaeoplacer area of northern France to Germany, south-western Norway, and northern Sweden (Salpeteur *et al*. 2005). In central Macedonia and Thrace in Greece the high Er values are related to felsic rocks and mineralisation. Point Er anomalies appear in western Greece, associated with *terra rossa* soil and phosphorite mineralisation, and in northern Ireland near the Mourne granite.

In topsoil, the Er pattern is very similar to that of the subsoil. There is a point anomaly in Gran Canaria in alkali basalt.

Erbium in soil has a strong to very strong correlation with the other REEs. The geochemical behaviour of Er is most similar to that of the other heavy REEs (Gd, Tb, Dy, Ho, Tm, Lu and Yb). For more information, see the section on REEs.

Er in stream water

Erbium values in stream water range over two and a half orders of magnitude, from <0.002 µg l^{-1} to 0.48 µg l^{-1} (excluding an outlier of 2.08 µg l^{-1}), with a median value of 0.006 µg l^{-1}. Erbium data correlate most closely with the rare earths elements in general, but in particular with yttrium.

See section on REE for a general discussion.

Lowest Er values in stream water (<0.002 μg l^{-1}) are predominantly found in most of eastern Spain, in western, south-eastern and north-eastern France, in southern Italy (including Sicily and southern Sardinia) and most of northern Italy, in western Slovenia, Croatia and western Austria, in north-eastern Germany, in throughout Albania and Greece. Most of the areas of lowest values are characterised by Alpine Orogen terrains (southern Europe), whereas other areas (mainly northern Germany) are characterised by glacial drift.

Highest Er concentrations in stream water (>0.093 μg l^{-1}) are predominantly found in northern Denmark, in southern Sweden and Finland. The areas of highest values are found on Precambrian Sveconorwegian and Svecofennian terrains (mostly intrusive and metamorphic rocks). Enhanced Er values (between >0.03 μg l^{-1}) also occur throughout central and southern Norway, in central and northern Sweden and Finland, eastern and northern Ireland, northern Scotland, characterised by Fennoscandian and Irish-Scottish Caledonides, and in France (Brittany and Massif Central) by Variscan terrains (intrusive and volcanic rocks). In northern Ireland, the anomalously high Er data are associated with the Mourne granite. Highly anomalous Er values in northern Germany are associated with high DOC values.

Er in stream sediment

The median Er content in stream sediment is 2.6 mg kg^{-1}, and the range varies from 0.07 to 46 mg kg^{-1}.

The Er distribution map shows low stream sediment values (<1.83 mg kg^{-1}) in east and north Finland, in the northern European plain from Poland to the Netherlands on glacial drift, in western Ireland, in parts of south, east and north Spain, in the French-Swiss Jura Mountains, in the western Alps and the northern Apennines, part of the south Apennines, in north-easternmost Italy, coastal Croatia, western and southern Greece.

The two areas with the highest Er values in stream sediment are the Variscan part of the Iberian Peninsula, *i.e.,* north Portugal, Galicia and the Sierra de Gredos in Old Castilia (Spain), and the Massif Central in France (Variscan granite), extending into the Poitou region to the north-west. High Er (>3.57 mg kg^{-1}) also occurs in most of Norway, north Sweden, parts of south and east Sweden, a point anomaly in northern Estonia (phosphate deposits), eastern Scotland, the Bohemian Massif, Albania, and a point anomaly near the Mourne granite in Ireland.

Erbium in stream sediment has a strong to very strong correlation with Th, U and the REEs. For more information, see the section on REEs.

Er in floodplain sediment

Total Er values in floodplain sediment, determined by ICP-MS, vary from 0.1 to 12.2 mg kg^{-1}, with a median of 1.96 mg kg^{-1}.

Low Er values in floodplain sediment (<1.31 mg kg^{-1}) occur in northern and eastern Finland on gneiss and greenstone of the Fennoscandian Shield, and the glacial drift covered plain from north Germany to Poland; the Ebro basin, Cantabria, Pyrenees, Galicia, La Mancha and Valencia in Spain on chiefly clastic and partly calcareous rocks; the alluvial sediments of the lower Garonne river in France; north-central Austria mostly on molasse deposits; in central Greece on calcareous and clastic rocks.

High Er values in floodplain sediment (>2.76 mg kg^{-1}) occur over the metamorphic and felsic igneous rocks and mineralised areas of the Precambrian Shield in northern, central and southernmost Sweden, northernmost and south-west Finland, and almost the whole of Norway; on glacial outwash cover in Estonia, where there may also be an association with phosphorite mineralisation. High Er values in floodplain sediment occur in France over the Massif Central on crystalline rocks, and north part of the Paris Basin on mostly carbonate rocks; in northern Portugal and Galicia, and Sierra Morena in southern Spain they are associated with felsic

rocks and mineralisation; in central Swiss-Italian Alps with felsic intrusives and mineralisation, the Roman Alkaline Province, and Corsica over granite and schist; an extensive area with felsic rocks and mineralisation begins from the Harz Mountains, Erzgebirge, Bohemian Massif to Brno (Li deposits) in the Czech Republic and ends in north-eastern Austria on Tertiary and Quaternary sediments; southern Austria with felsic intrusives; high Er values in floodplain sediment of Slovenia and Croatia, except Dalmatia, are explained by possible concentration in karstic soil; in eastern Hungary the Er anomalous values are probably due to the mineralisation in the Apuseni Mountains in neighbouring Romania.

In conclusion, granite, granodiorite, shale, sandstone and schist lithologies show the highest Er concentrations in floodplain sediment, and the glacial drift covered terrain (north-east Germany and Poland) the lowest; low Er contents are also generally found in calcareous areas (*e.g.,* eastern Spain, Greece and Dalmatian coast), except where there is intense development of residual soil in karst terrain (*e.g.,* Slovenia and Croatia). The distribution map of total Er in floodplain sediment shows, therefore, the geochemical differences of the geological substratum and mineralised areas quite well, and no distinguishable influences from anthropogenic activities are recognised. It is noted that the spatial distribution of Er is similar to that of other HREEs (Dy, Gd, Ho, Lu, Tb, Tm, Yb).