INDUSTRIAL GARNET SAND AS A POTENTIAL SECONDARY RESOURCE FOR SCANDIUM IN EUROPE

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Abstract

Scandium is classified as a critical raw material by the European Union and is thus considered to be of crucial importance for the EU economy. Due to the absence of a long-term reliable source for Sc, technologies based on Sc such as Al-Sc alloys are not widely used yet. However, as the demand for Sc increases, several projects worldwide now focus on the development of such a Sc resource. In Europe, the main interest is on secondary resources, i.e. the recovery from waste products such as red mud. In this study, the focus is placed upon industrial garnet sand as a potential secondary resource for Sc. Several industrial garnet sands as well as samples from garnet sand mines were analysed and showed average Sc concentrations of around 96 ppm which places them within the same concentration range as other waste products currently investigated as a potential resource.

Introduction

Scandium is classified as a critical raw material by the European Union since 2017 and is, therefore, considered to be of special importance to the economies in the EU. Beside other applications, it has the potential to be used in solid oxide fuel cells and Al-Sc alloys that are important for the aerospace and transportation industry. The use of Al-Sc alloys in the aerospace industry, for example, would lead to a reduction in weight of the airplanes and, therefore, to a reduction of fuel consumption, resulting in reduced cost and emissions. Currently, these technologies are not widely used, as there is no reliable and secure long-term source available to guarantee uninterrupted supply. As the demand for Sc is increasing and this trend is expected to continue, several projects worldwide are focusing on the development of such a source with the goal to rectify this dire situation. The focus in Europe lies upon the development of secondary resources. Currently considered is the recovery of Sc from waste products of bauxite mining such as red mud.

Industrial garnet sand could be an additional secondary resource for Sc. Garnet in general has elevated Sc concentrations compared to many other rock-

forming minerals due to the substitution of Sc^{3+} for Fe^{2+} and Mg^{2+} in the crystal lattice structure of garnets. Industrial garnet sand is used in several industries, for example, for sand blasting and water-jet cutting. As the material properties of industrial garnet sand remain largely unchanged during these processes, industrial garnet sand can repeatedly be recycled and reused before it is eventually disposed.

Results

In this study, industrial garnet sands from six different suppliers in Germany and from six different garnet mines around the world were analysed for Sc and rare earth elements. The garnet sand samples from the mines include samples from Port Gregory, Australia, and Tamil Nadu, India, therefore covering the two main supplying regions for industrial garnet sands worldwide. All samples investigated in this study show elevated Sc concentrations compared to the continental crust. The average Sc concentration in the industrial garnet sands and the garnet sands from the mines are rather similar with 95.2 ppm (with a maximum of 124 ppm) and 96.1 ppm (with a maximum of 133 ppm), respectively. Two samples of metamorphic and hydrothermal garnet, respectively, showed anomalously low concentrations that were only slightly above that of average continental crust; these samples were excluded from the aforementioned averages.

The industrial garnet sands included also samples from recycled garnet sand with similar Sc concentrations to non-recycled sand, showing that the chemical composition of the industrial garnet sand remains unchanged.

Our results clearly demonstrate that the Sc concentrations in the garnet sands studied fall well within the range of those of other waste products currently considered for Sc recovery in Europe, such as red mud in Greece which shows an average Sc concentration of 113 ppm[1].

Hence, the recycling of industrial garnet sand may serve as a potential secondary resource in Europe and contribute to an enhanced efficiency in the use of georesources.

References

1. Ochsenkühn-Petropoulou, M., Tsakanika, L-A., Lymperopoulou, T., Ochsenkühn, K-M., Hatzilyberis, K., Georgiou, P., Stergiopoulos, C., Serifi, O., Tsopelas, F.,"Efficiency of Sulfuric Acid on Selective Scandium Leachability from Bauxite Residue", in *Open Access Journal of Mining & Mineral Processing* (2018)