Rock porosity and element distribution in an extremely acid-sulphate altered Tertiary Latite, Styria, Austria: A comparison

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Introduction

The Tertiary Latite of the Gleichenberg Volcanic Area, Styria, Austria is part of a volcanic province named Transdanubian Volcanic Region (Embey-Isztin, 1990; Kurat *et al.*, 1991). The latite has in places been completely altered by hydrothermal acid sulphate solutions. The alteration processes result in the area of the Gossendorf open-pit mine in alteration products which consist of various associations of the secondary minerals opal-C/-CT, alunite, kaolinite and montmorillonite. These alteration products occur in a zonal arrangement: Samples of the innermost zone consisting of opal-C/-CT are followed by opal-C/-CT + alunite and opal-C/-CT + alunite + kaolinite (middle zone I) and opal-C/-CT + alunite + kaolinite + montmorillonite (middle zone II). In the outermost zone montmorillonite is the main alteration product. Altered samples consisting almost exclusively of opal-C/-CT (inner zone) typically contain no parent rock but have retained the original latite structure (Barth-Wirsching *et al.*, 1990). Moreover, they are characterized by uniform SiO_2 contents of about 90.0 wt.% but by different values of TiO_2 (1.2–3.5 wt.%) and of porosity (1.4–55.0 vol.%). All the other major, minor and common trace elements are extremely discharged. The purpose of this study is to investigate if in altered samples consisting of opal-C/-CT only, the chemical data (SiO_2/TiO_2 distribution) correlate with physical rock properties (porosity).

Analytical methods

Qualitative as well as quantitative mineralogical compositions were analyzed by X-ray powder diffraction (Philips PW 1800/00/01) and Guinier method (Guinier double chamber after Jagodzinski). The chemistry of the alteration products was determined by X-ray fluorescence spectroscopy (Philips PW 1410/10). Porosity and pore-radii distribution were analyzed by Hg-porosimetry (Quantachrom Autoscan-33 porosimeter).

Results

Chemical data of altered samples, except of those which consist of opal-C/-CT only, show a high scatter not only between different but also within individual zones. The high data scattering within the individual zones is in relation with the extremely different quantitaty of the secondary minerals especially in the middle zone. The major, minor and common trace elements, except of SiO_2, are extremely discharged in altered samples consisting of opal-C/-CT only. In contrast, TiO_2 is increased in respect to the 'unaltered' latite. Critical tests with binary plots for immobility of elements, using the correlation coefficients as a gauge of mobility, show, that only TiO_2 might be immobile during these extremely acid-sulphate alteration processes. The frequent occurrence of the Ti-phase anatase confirms this assumption.

Mass change calculations of SiO_2 with TiO_2 as the immobile monitor reveal quite different reactions. Samples show both SiO_2 gains and

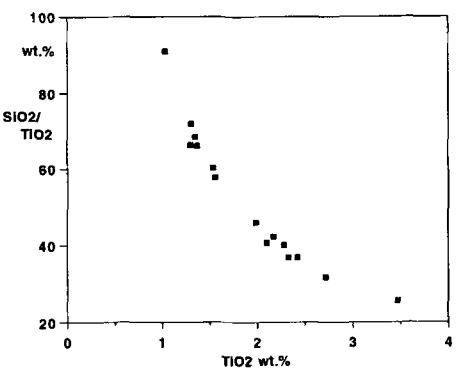

FIG. 1. SiO_2–TiO_2 distribution of samples consisting of opal-C/-CT.

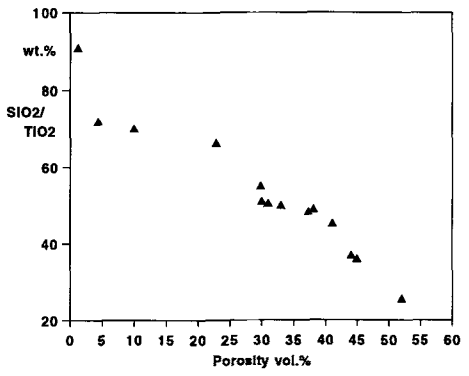

FIG. 2. Correlation between SiO_2/TiO_2 ratios and porosities of samples consisting of opal-C/-CT.

losses. The high scatter of gains and losses refers to the extreme mobility of SiO_2 under these conditions although samples consist of a microcrystalline SiO_2-phase (opal-C/-CT) only. Exclusively mass losses were calculated for all the other elements investigated. The high TiO_2 content of these samples, however, indicates that they are altered rock and not a deposit of siliceous sinter. The SiO_2-TiO_2 distribution shows a very good correlation between Ti and Si, whereby an increase of TiO_2 refers to a drastic decrease of SiO_2.

The material changes of SiO_2 correspond also with the porosity investigated (Klammer, 1991). Plots of SiO_2/TiO_2 ratios versus porosity (1.4–55 vol.%) show for low ratios high porosity and vice versa. High porosities refer to net losses of SiO_2, net gains, however, are observed in altered samples with a porosity below 5 vol.%, exclusively.

Volume change calculations show generally volume decreases up to a maximum of about −70 vol.%. In contrast to these observations Schoen *et al.* (1974) found, refering to the porosity of most altered andesite, only a stable behaviour of SiO_2 in the silica cap at Steamboat Springs, Nevada.

Conclusions

Major, minor and common trace elements were investigated from a hydrothermaly acid-sulphate altered latitic rock in the Gleichenberg Volcanic Area, Styria, Austria. The most altered rocks are mined in a open-pit near Gossendorf and are arranged in a zonal distribution. Samples of the innermost zone consist of opal-C/-CT only and are characterized by: a) Extreme mobility of all elements investigated except of TiO_2; b) Extreme net mass losses of all elements except of SiO_2 which shows mass gains also; c) A good correlation between TiO_2 and SiO_2. The increase of TiO_2 refers to the drastic decrease of SiO_2; d) A correspondence between SiO_2/TiO_2 ratios and the rock porosities; high ratios show high porosities and vice versa; e) A good correlation between porosity and mass change of SiO_2: net mass losses correlate with high porosities, net mass gains with low porosities. These SiO_2 gains are caused by diffusion of the SiO_2 content available in the latite from places of SiO_2 losses and do not come from outwards of the geothermal system; f) A correspondence between the calculated volume decreases up to −70 vol.% which refer to high SiO_2 losses and high porosities.

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