Buchite type glasses in the West Eifel Volcanic Field (Germany)

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Sedimentary siliciclastic xenoliths from Devonian and Triassic source rocks, pyrometamorphically overprinted by cooling volcanic deposits, are common in numerous scoria cones in the West Eifel Volcanic Field (WVF). Some of these upper crustal rock fragments are affected by anatexis and high-temperature metamorphism leading to formation of pyrometamorphic glasses.

We have systematically mapped 71 phreatomagmatic scoria cones in the WVF and performed thermoanalytical and geochemical analyses on sampled glasses and xenoliths. The compilation of the results led to the development of a petrological model. According to the obtained p-T-X-conditions during formation these glasses can be classified as 'buchites'. They have rhyolitic to trachytic compositions and can be grouped into two subtypes.

Buchites of subtype-I occur in agglutinates, agglomerates and less often in welded scoria deposited in proximal areas of the crater. These pyrometamorphic siliciclastic xenoliths form a glassy rim of variable thicknesses (a few hundred microns to more than 3 mm) and show predominantly translucent colors (e.g. dark blue, turquoise, moss-green, yellow to green, brown to purple and grey).

Buchites of subtype-II are restricted to compact basalts outcropping in former lava lakes, lava flows and along fissures. These rocks contain inclusions of almost homogeneously moss-green to green-brown colored massive glasses.

An important consideration of the petrological model is the formation of scoria cones by initial phreatomagmatic eruptions, with fragmentation of source rocks during eruption and an incorporating of siliciclastic xenoliths in the ascending magma. These xenoliths were (partially) melted and annealed slowly (500>t>3yr) under *in situ* reducing conditions and low temperatures (534-635°C). A further crucial precondition in the formation of the buchites is the influx of volatile phases (H_2O>>CO_2>>H_2S/SO_2≥HF) released by the host magmatic hydrothermal system. This hydrothermal system causes leaching of specific elements (Pb, Zn, Al, Na, K and also chromophores like Cr, Cu, Fe, Mn, V) from the volcanic rocks and their enrichment in the buchites. An increase of silica in the buchites is due to its mobilization from the siliciclastic upper crust xenoliths.

Geoelectrochemical model of ore formation on the base experimental data

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Numerous self-potential (SP) anomalies are known to exist in upper continental and ocean crust [1]. SP anomalies represent both local and regional electric fields. The most widespread SP anomalies associated with hydrothermal and subsurface water flow (steaming potential) [2]. Under the influence of electric energy electrochemical processes are inevitable. These processes include: the extraction of elements from rocks, migration of charged particles in the domains of the poles and a concentration in these local areas. Existing geophysical data allow the quantitative estimation of redistribution of elements in the geoelectrochemical cell (system). For example, in the case of local electrical fields with sections of electrochemical cells, e.g. 100 km^2, a direct current of approximately 10^3 A is generated. According to Faraday's Law, in a period of around 1 million years, approximately 10^8 tones of substance should be transported within the geoelectrochemical system.

This electrochemical processes study was carried out during the development of the CHIM method between 1960 and 1990 [3]. Experimental data showed that under the impact of electrical energy, a selective release of ore elements from rock depending on the form of their occurrence from 20% or more took place, while the degree of release of macro-components did not exceed 0.4%. Such high degree of release of ore elements can be achieved in a period not exceeding 1 million years. According to experimental data on ion mobility, the scope of the migration of elements could be tens of kilometers. As a result geochemical systems with depletion and enrichment zones of ore elements can be formed. Such systems have to be characterized by ellipse-like structure, in accordance to the structure of electric fields.

Similar geochemical system patterns for mineral targeting of various types and structures have been established by geochemical researches [4, 5]. Good correlation exists between the dimension of the systems and the reserve of metals in mineral targeting [5]. Such systems are formed as open far from equilibrium (self-organized systems) and can be considered as ore-forming systems.

[1] Reynolds (1998) *W&S*, 778. [2] Rapolla (1974) *Geotermics* **3**, 118–121. [3] Goldberg *et al*. (1999) *U.S.G. S. Open-File* **90–462**, 172. [4] Goldberg *et al*. (2003) *J. Geochem, EEA*. **3**, 281–293 [5] Goldberg *et al*. (2007) *Economic Geology* **102**, 745–753.