### 3.6.P12

# Evolution of sulphide mineralization in ferrocarbonatite, NW Namibia: Constraints from sulphur isotopes

K. DRÜPPEL[1], T. WAGNER[2] AND A.J. BOYCE[3]

[1] Montanuniversität Leoben, Austria
(kirsten.drueppel@gmx.de)
[2] Universität Tübingen, Germany
(th.wagner@uni-tuebingen.de)
[3] Scottish Universities Environmental Research Centre
Glasgow, Scotland (a.boyce@suerc.gla.ac.uk)

Proterozoic ferrocarbonatite dykes (1140-1120 Ma) of Swartbooisdrif, NW Namibia transsect the anorthositic rocks of the Mesoproterozoic Kunene Intrusive Complex. The carbonatites are highly contaminated by fragmented and fenitized wallrock anorthosite and are mainly composed of ankerite, albite, magnetite, biotite and sodalite; minor components are cancrinite, muscovite, pyrochlore, apatite, calcite, dolomite, ilmenite and Fe-Cu-Ni sulphides. Sulphides were additionally observed in metasomatic zones surrounding large carbonatite bodies.

To investigate the evolution of sulfur isotopes during the progressive crystallization and subsolidus re-equilibration of the ferrocarbonatites, early, euhedral pyrite as well as pyrite and chalcopyrite from late-stage sulphide-oxide veins (assemblage: pyrite, chalcopyrite, millerite, polydymite, fletcherite, magnetite/hematite) were analysed for $\delta^{34}S$ using an in situ laser microprobe. The data were complemented by analyses of metasomatically formed pyrite hosted by fenitized anorthosite. The $\delta^{34}S$ values of early carbonatite-hosted pyrite are in the range of 3.76-5.13‰, about 4‰ higher than the $\delta^{34}S$ range of the pristine mantle. Remarkably, similar $\delta^{34}S$ values have been obtained for metasomatically formed pyrite from the fenitized anorthosites (3.27-3.40‰). Distinctly lower, negative $\delta^{34}S$ values were determined for pyrite (-0.03 to –3.25‰) and chalcopyrite (-0.03 to –1.31‰) in late sulphide-oxide veins, with the lowest values obtained for pyrite (-2.07 to –2.43‰) and chalcopyrite (–2.84 to –3.25‰) from samples which also contain secondary barite. The sulphides evolve along a continuous trend toward more negative $\delta^{34}S$ related to an increase of the oxygen fugacity. This trend can be interpreted in terms of changing proportions of oxidised and reduced S species in the carbonatite magma, which is supported by calculations of phase equilibria in the system Cu-Fe-S-O-H and modelling of isotopic mass balance. (1) During the early stages of crystallization the oxygen fugacity was presumably low, whereas the proportion of the reduced S species ($H_2S$) was high, promoting pyrite precipitation and the metasomatic formation of almost pure, $SO_4$-free sodalite. (2) A subsequent increase in $fO_2$ led to a systematic increase in the $SO_4/H_2S$ ratio of the fluid. This resulted in a depletion of the remaining reduced sulphur in $^{34}S$, which is manifested by the negative $\delta^{34}S$ values of the late sulphide mineralization.

---

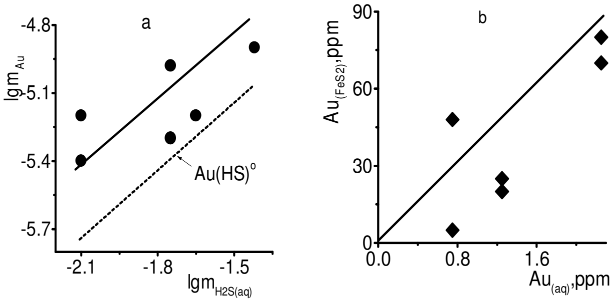
### 3.6.P13

# Solubility and mass transfer of gold between Au (met) and $FeS_2$ under hydrothermal conditions

K.B.ROZOV[1] AND YU.V.LAPTEV[2]

[1] Novosibirsk State University, Novosibirsk, Russia
[2] Institute of Mineralogy and Petrography SB RAS,
Novosibirsk, Russia (stalja@nsu.ru;
laptev@uiggm.nsc.ru)

It is shown [1,2] that at room temperature the mass transfer of Au between solution and pyrite surface goes adequately after the mechanism of adsorption capture. For the conditions of elevated temperatures our experiments were the first. We carried out an experimental study of Au (I) distribution under isothermal conditions (300°C, P=150bar, autoclave method) between pyrite and gold according to the scheme: Au (met) → solution → $FeS_2$. The pyrite monofraction (<250mkm) of Berezovsky deposit, South Urals has been used in the experiments. It has been mixed with 0,1m NaCl solution during 4-8 hours. The dozed amounts of elementary sulfur have provided the conditions of the fixed red-ox potential (it completely dissolves at 300°C by the known scheme: $4\ S_{(el)} + 4\ H_2O\ =\ 3\ H_2S_{(aq)} + HSO_4^- + H^+$).



The gold contents found in the solutions relative to hydrogen sulfide concentrations can be correlated for the equilibrium Au(met) + $H_2S$(aq) ↔Au(HS)° + 0,5$H_2$(aq). It follows from the experimental data and results of calculation-thermodynamic modeling (broken line), given in Fig. (a). By the positive correlation of gold contents in the pyrite fraction and solution (Fig. b), estimation of the value of the apparent coefficient of distribution $D=[Au]_{(FeS2)}$,ppm/$[Au]_{(solution)}$,ppm) shows the value 35±8. The obtained results demonstrate significant role of the gold mass transfer processes under hydrothermal conditions of sulfide formation.

The work was funded by the RFBR (02-05-64623) and UniRuss (UR-09-01-019).

## References

[1] Widler A.M., Seward T.M. (2002) *G.C.A.* **66,** 383-402.
[2] Phadeev V.V., Koserenko S,V. (1999) *Geochem. Int.* **12**, 1313-1322.