Re-Os constraints on gold mineralisation events in the Neo-archaean Storø supracrustal belt, Southern West Greenland

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The Storø supracrustal belt in Godthåbsfjord, southern West Greenland, hosts gold mineralization that is associated with arsenopyrite along a contact between lithological units and along the axial plane of a large fold core. Here we present new arsenopyrite Re-Os and zircon U-Pb data to constrain the age of the debated Storø gold deposit. Arsenopyrite from a stratiform mineralisation yield a 2.71 ±0.05 Ga isochron and model ages for highly radiogenic arsenopyrite form a bimodal distribution with peaks at 2.66 Ga and 2.71 Ga respectively. The older population combined with the isochron result yields a weighted mean of 2.707 ±0.008 Ga (MSWD = 0.57, n=4). A 2.64 ±0.02 Ga isochron from arsenopyrite from the axial plane of the fold core indicate a two-stage mineralisation process. The 2.64 ±0.02 Ga isochron is in perfect agreement with U-Pb zircon data (Nutman *et al*. 2007. Prec. Res. 159, 19-32), which are best explained by orogenic mineralisation during amphibolite facies metamorphism along structural weak planes. The initial $^{187}Os/^{188}Os$ value of 0.56 ±0.16 for the 2.64 ±0.02 Ga isochron indicates a crustal source for the metals, whereas the initial $^{187}Os/^{188}Os$ = -0.1 ±0.6 for the 2.71 ±0.05 Ga isochron remains unconstrained. Nevertheless, these data are best explained by relatively short crustal residence times of less than 0.1 Ga, wherein the Os, and associated metals, were extracted from the mantle after 2.8 Ga, and in which the 2.64 ±0.02 Ga stage formed by mobilisation of an earlier mineralisation around 2.72 Ga. Such a model is corroborated by detrital zircon constraints, which imply that volcanism and the first mineralisaton stage is ≤2.8Ga. Finally, the ~2.63 Ga amphibolite facies metamorphic event in the Storø supracrustal belt was important for the redistribution of gold bearing sulphide minerals.

Marcasite in clastic sediments – Formative processes and deep time stability

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Marcasite occurs in marine and brackish water shale, claystone, and sandstone units from multiple locations and ages (Proterozoic through Eocene). Textural observations, such as differential compaction around marcasite concretions, indicate that these marcasites formed during early diagenesis in surface sediments. In marine shales and sandstones, textural studies suggest that marcasite precipitation is intimately associated with corrosion and destruction of framboidal pyrite for the former, and with destruction of reworked early diagenetic pyrite concretions for the latter. Marcasite formation in association with pyrite destruction is consistent with a scenario whereby earlier formed diagenetic pyrite is re-oxidized in surface environments to produce the low-pH conditions required for marcasite formation.

In brackish water claystones, marcasite occurs as radial fibrous masses along the margins of burrows that penetrated into reducing sediments. Soil science research that associates marcasite formation with water-logged acid sulfate soils in coastal settings suggests that this marcasite as well formed because oxidation of pre-existing iron sulfides provided favorable conditions for marcasite growth.

Marcasite concretions from both marine and brackish water settings show multiple generations of marcasite growth, and $\delta^{34}S$ values were measured from successive generations in micro-drilled samples and by ion-probe. The data show the lowered $\delta^{34}S$ values indicative of microbial sulfate reduction in surface sediments, as well as a wide range of $\delta^{34}S$ values suggestive of variable degrees of system closure (marine) and salinity fluctuations (brackish).

The studied samples range from approximately 50 million to 1.6 billion years in age and were all collected from unmetamophosed sediments. Marcasite is considered metastable and thought to invert to pyrite over time. Our observations indicate that this conversion proceeds very slowly at low temperatures (<200ºC). In general, partial conversion of marcasite to pyrite is minor to absent for fine grained sediments (shales and claystones), and common and completed to various degrees in sandy sediments.