Geology, texture and zonation micro-characterisation of cassiterite from Karagwe Ankole Belt (Rwanda), Center-east Africa

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Cassiterite (SnO2), one of the main ore minerals for tin (Sn), belongs to the mineral group of rutile and commonly crystallises in magmatic and magmatic-hydrothermal environments associated with highly fractionated granites. The mesoproterozoic Karagwe Ankole Belt (KAB), in center-east Africa, is one of the occurrences of cassiterite deposits where the mineralisation principally occurs in hydrothermal quartz veins that are presumably related to granite plutons. The attempts of tin metallogenetic study in KAB have been previously reported but the enhanced characterisation of cassiterite from this region is poorly addressed. This study focuses on the geology, textural and micro-characterisation of cassiterite from Rwanda, from the central part of the KAB. The field evidence, petrography and electron microprobe studies of cassiterite are used to characterise the major tin mineralisation in Rwanda, KAB.

The field investigation in south-eastern part of Rwanda, at Rwinkwavu, shows that cassiterite is closely associated with muscovite, within quartz veins which are mainly intruded into the quartz mica schists. The contact between tin mineralised quartz veins and host rocks is also characterised by presence of abundant muscovites which suggests that the tin precipitation resulted from acid neutralising muscovitisation reactions with the host rock surrounding the quartz veins. The petrographic observation of tin mineralised quartz veins reveals that the contact between individual quartz crystals is irregular and subgrains which are present at the contact zone have the same interference colours as neighbouring crystals. This indicates the low-temperature grain boundary migration or bulging recrystallisation which might be associated with mineralising hydrothermal fluids. The fluid inclusion micro-thermometric study reveals that the cassiterite precipitation occurred from a fluid at homogeneous temperature between 184ºC and 312ºC.

Pleochroism and megascopic colour zonation, varying between light brown and dark brown, are observed for the investigated cassiterite. These zones are different in composition caused by chemistry variation of elements substituting with Sn as proved by electron probe microanalysis of same samples. This study shows that the dark brown zones are characteristically enriched in Nb, Ta, Ti and Fe relative to the lighter zones which are nearly close to pure SnO_2. The calculated element content in a cassiterite formula shows that Nb/Ta ratios range from 0.31 to 5.29 and (Nb+Ta)/(Fe+Mn) between 0.32 and 4.35. There is a reasonable correlation between $[(Nb+Ta)/Sn]_{atom}$ and $[(Fe+Mn)/Sn]_{atom}$ which implies the incorporation of these elements in cassiterite via the substitution scheme: $2(Nb+Ta)^{5+} + (Fe+Mn)^{2+} = 3Sn^{4+}$. Besides the scheme above, the atomic ratios Fe – (Nb+Ta) – (Sn+Ti) ternary systems show that the substitution $Fe^{2+} + 2(Nb+Ta)^{5+} = 3(Ti+Sn)^{4+}$ can also be appropriate for the investigated cassiterite. Small rutile inclusions are also observed to be randomly disseminated in cassiterite due to isostructure of these two minerals.

Our study shows that the investigated cassiterite has alternate growth zones of different composition, with more enrichment of Nb,Ta, Ti, Fe in darker zones than lighter ones, and formed from hydrothermal fluids of which the tin dominantly precipitated by wall-rock interaction mechanism.