Phyllosilicate Ar-Ar and Rb-Sr geochronology in the Gitarama-Gatumba area (Rwanda): an important Neoproterozoic influence in the Karagwe-Ankole Belt

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1.Introduction and geological setting

The Karagwe-Ankole Belt (KAB) is an orogenic belt in Central-Africa, situated between the Congo Craton (W) and the Tanzania Craton (E). At ~1375 and ~986 Ma, two S-type granite generations, termed the G1-G3 and G4 granites in Rwanda, respectively, intruded the Mesoproterozoic metasediments (Tack et al. 2010). The broader geodynamic context in which these magmatic intrusions and related early Neoproterozoic Nb-Ta, W and Sn ore deposits were emplaced is still a controversial topic. Currently, two contrasting tectono-magmatic models exist for the KAB during the Mesoproterozoic, i.e. an intracratonic versus an active margin setting (e.g. Tack et al. 2010; Debruyne et al. 2015). At the end of the Neoproterozoic, at ~550 Ma, a NS-oriented, Pan African overprint affected the KAB, caused by the amalgamation of Gondwana (Fernandez-Alonso et al. 2012). To clarify the timing of metamorphic and deformational events, an extensive geochronological survey of phyllosilicates from the Gitarama-Gatumba area, West Rwanda, was carried out by step-heating Ar-Ar and in-situ LA-ICP-MS Rb-Sr analyses.

2.Ar-Ar and Rb-Sr results

An Ar-Ar plateau age of 625±2 Ma is obtained for biotite from the rim of bedding-parallel quartz pods. Phyllosilicate pockets observed in inter-boudin quartz veins of a boudinaged pegmatite show Ar-Ar ages between 591±2 Ma (muscovite) and 567±2 Ma (biotite). The Rb-Sr phyllosilicate geochronology results of the Gitarama-Gatumba area can be subdivided into two age populations. First of all, a group of late Meso- to early Neoproterozoic ages (1082 – 893 Ma) can be distinguished. These are all ages of muscovite crystals from various geological contexts (e.g. G4-granite, mylonitized G1-G3 granite, crenulated muscovite schist) which show an extremely large uncertainty (~75 Ma, with an exception of 280 Ma), due to the limited intra-crystal variation in $^{87}Rb/^{86}Sr$-ratio. Within error, the ages are contemporaneous, with an average of around 954 Ma. Second, a group of much younger, late Neoproterozoic to early Cambrian ages was observed, mostly for biotite, but in some cases also for muscovite. The muscovite ages vary between 609±140 and 526±86 Ma, the biotite ages between 531±3 and 486±5 Ma.

3.Discussion and conclusion

The oldest Rb-Sr age population (average of 954 Ma) can be linked to pervasive metasomatism associated with the G4 granite intrusions or regional cooling till below the muscovite Rb-Sr closure temperature (500 – 550 °C). This is reflected by the contemporaneous ages of multiple, petrographically different muscovite samples. A distinction between the two possibilities cannot be made. The oldest Ar-Ar biotite plateau age suggests the temperature had dropped to 300 – 350 °C by 625±2 Ma. However, Ar-Ar age spectra demonstrate that partial isotope resetting took place in inter-boudin phyllosilicate at 591±2 and 567±2 Ma. The youngest group of Rb-Sr ages also indicates that widespread recrystallization, mainly of biotite, took place at a later stage. This partial to complete resetting corresponds to the late Neoproterozoic hydrothermal activity in the area, which has been reported by Cahen et al. (1984) and others.

Unfortunately, the phyllosilicate geochronological data do not provide information on Mesoproterozoic deformation events. Nevertheless, the phyllosilicate ages of the Gitarama-Gatumba area indicate the occurrence of multiple important geological events in West Rwanda, and by extension in the Western Domain of the KAB, during the late Neoproterozoic to early Cambrian. Regional closure to temperature-driven diffusion was reached prior to 625±2 Ma, both for the Rb-Sr and Ar-Ar systems. Therefore, younger obtained ages record the occurrence of recrystallization due to local deformation and fluid circulation. These processes affected the phyllosilicates from shortly prior to the assembly of Gondwana in the east (around 550 Ma) till at a syn- to post-amalgamation stage.

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