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Unravelling the enigmatic Grampian Shear Zone: In-situ monazite and titanite U-Pb analysis of the juxtaposed Badenoch and Grampian Groups

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The Grampian Shear Zone (GSZ) represents a highly deformed tectonostratigraphic contact between the Proterozoic metamorphic rocks of the Dalradian Group from the underlying high grade metamorphic Neoproterozoic rocks of the Badenoch Group within the Grampian Highlands. The nature (tectonic suture or palaeo-unconformity), age and structure of the GSZ and indeed the underlying Badenoch Group are poorly constrained. Previous studies of the GSZ and synkinematic (intruded during shearing) pegmatites found therein, yielded metamorphic/deformation (and magmatic) ages ranging from c.a. 808 to 440 M. This study reinvestigates this shearzone using in-situ (within section) petrochronological analysis on a range of U-Pb and Rb-Sr chronometers – Monazite, zircon, titanite, rutile and mica. Carrying out this analysis in-situ and using a variety of minerals allows us to directly date deformation fabrics over a wide range of deformation temperatures, giving us a far more detailed picture of the events recorded within these rocks. Large monazite grains ($\geq 100\mu\text{m}$) were mapped using in-situ LA-ICP-MS to show within grain variation of major elements and REEs. Monazite U-Pb spot analysis from the GSZ has yielded ages ranging from $784.11 \pm 1.2\text{Ma}$ to $442.58 \pm 0.58\text{Ma}$. The same analysis was performed on a sample from the Grampian group which yielded an age of $441.34 \pm 0.37\text{Ma}$. In addition to this monazite data, in-situ U-Pb Titanite analysis from the Badenoch Group gave ages of $526.96 \pm 1.33\text{Ma}$ from a metabasite sample, with a metasedimentary sample giving a range of titanite U Pb ages from 540 to 460Ma. These age ranges show that the Badenoch Group and the GSZ have recorded a complex polyorogenic history relative to the “simple” overlying Dalradian metasediments. We propose that the Grampian Shear Zone represents a deep-seated Knoydartian (808 to 784Ma) age shear zone within the meso-Neoproterozoic Badenoch Group. This shear zone was then reactivated during the Grampian phase of the Caledonian Orogeny resulting in the tectonic emplacement of the Dalradian metasediments above the Badenoch group.