

Age and geochemistry of the Charlestown Group, Ireland: implications for the Grampian orogeny, its mineral potential and the Ordovician timescale

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Accurately reconstructing the growth of continental margins during episodes of ocean closure has important implications for understanding the formation, preservation and location of mineral deposits in ancient orogens. The Charlestown Group of Co. Mayo, Ireland, forms an important but understudied link in the Caledonian-Appalachian orogenic belt between the well-documented sectors of western Ireland and Northern Ireland. We have reassessed its role in the c. 474-465 Ma Grampian-Taconic orogeny, based on new fieldwork, high-resolution airborne geophysics, graptolite biostratigraphy, U-Pb zircon dating, whole rock and an examination of historic drillcore from across the volcanic inlier. The Charlestown Group is divisible into three formations: Horan, Carracastle, Tawnyinah. The Horan Formation comprises a mixed sequence of tholeiitic to calc-alkaline basalt, crystal tuff and sedimentary rocks (e.g. black shale, chert), forming within an evolving peri-Laurentian affinity island arc. The presence of graptolites *Pseudisograptus* of the *manubriatus* group and the discovery of *Exigraptus uniformis* and *Skiagraptus gnomonicus* favour a Yapeenian (= late Arenig; Ya2 stage) age for the Horan Formation (equivalent to c. 471.2-470.5 Ma according to the timescale of Sadler et al., 2009). Together with four new U-Pb zircon ages (471 to 469 Ma) this fauna provides an important new constraint for calibrating the middle Ordovician timescale. Overlying deposits of the Carracastle and Tawnyinah formations are dominated by LILE- and LREE-enriched calc-alkaline andesitic tuffs and flows, coarse volcanic breccias and quartz-feldspar porphyritic intrusive rocks, overlain by more silicic tuffs and volcanic breccias with rare occurrences of sedimentary rocks. The relatively young age for the Charlestown Group in the Grampian orogeny, coupled with high Th/Yb and zircon inheritance (c. 2 Ga) indicate the arc was founded upon continental crust (either composite Laurentian margin or microcontinental block). A regional correlation is favoured to the post-subduction flip volcanic/intrusive rocks of the Irish Caledonides, specifically the late-stage development of the Tyrone Igneous Complex, Murrisk Group ignimbrites, and late intrusive rocks of Connemara (western Ireland) and the Sliswood Division (Co. Sligo). Examination of breccia textures and mineralization across the volcanic inlier questions the previous porphyry hypothesis for the genesis of the Charlestown Cu deposit, features more consistent with a volcanogenic massive sulfide (VMS) deposit.