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‘Date to rate’: mining the sedimentary record to study tectonic rates and timescales

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The geochronological community now has access to a wide range of methods, minerals and decay systems with which to study the tectonic evolution of orogens, particularly ‘dates and rates’ of metamorphism and deformation. While the preferred dating targets involve direct investigation of metamorphosed and deformed rocks using petrochronological approaches, much of the rock record of orogenesis has generally eroded away, even in active orogens. Their erosional remnants preserved in syn-tectonic sedimentary basins thus provide a highly complementary record of the tectonic evolution of orogenesis. Sedimentary basins are commonly mined for their detrital mineral age populations (e.g. zircon U-Pb), and coupled isotopic analyses (e.g. Hf) allow for increasingly detailed source characterization. However, this is just the tip of the iceberg for information that can be extracted from syn-tectonic basins. In this case study, a range of approaches including detrital clast petrochronology, detrital multi-mineral thermochronology, and geo- and thermochronological double dating are applied to rocks from a syn-tectonic basin to interrogate the complex history of accretion in an accretionary orogen setting.

The Intermontane suite of continental, island arc and oceanic terranes accreted to the western margin of North America in Early Jurassic, initiating the Canadian Cordillera. The Whitehorse trough syn-tectonic basin preserves the erosional record of accretion of these terranes, including igneous, sedimentary and metamorphic sources. Petrochronology of mm-sized eclogite clasts reveals that peak high temperature metamorphism, rapid cooling and exhumation, and deposited into the basin all occurred during Early Jurassic. Detrital muscovite ages indicate exhumation of other metamorphic source rocks during E. Jurassic. U-Pb - U-Th/He double dating of detrital zircon confirms collapse of nascent volcanic rocks into the basin during the same period. Low temperature thermochronometers record post-E. Jurassic burial and shortening of the Whitehorse trough during ongoing collision. This comprehensive and diverse set of ‘date to rate’ data allows for new hypotheses on the tectonic setting of accretion in the Canadian Cordillera during the Early Jurassic.