# Microsampling Lu–Hf geochronology on mm-sized garnet

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This study presents Lu–Hf geochronology of zoned garnet in high-pressure eclogites from the North Qilian orogenic belt. Selected samples have ~mm-sized garnet that have been sampled with a micro-drill and analyzed for dating. The Lu–Hf dates of bulk garnet separates, micro-drilled garnet cores, and the remaining, rim-enriched garnet were determined by two-point isochrons, with cores being consistently older than the bulk- and rim-enriched garnet. The bulk garnet separates of each sample define identical garnet-whole rock isochron date of *ca.* 457 Ma. Consistent U–Pb zircon dates of 455 ± 8 Ma were obtained in the eclogite. The Lu–Hf dates of the drilled cores and rim-rich separates suggest a minimum garnet growth interval of 452.1 ± 1.6 and 468.9 ± 2.4 Ma. Major and Lu element profiles in the majority of garnets show well-preserved Rayleigh-style fractionated bell-shaped Mn and Lu zoning profiles and increasing Mg from core to rim. Pseudosection modelling for a selected sample indicates that garnet grew along a *P–T* path from ~470–525 °C and ~2.4–2.6 GPa. The exceptional high-Mn garnet core in one sample indicates an early growth during epidote blueschist-facies metamorphism at < 460 °C and < 0.8 GPa. Therefore, the Lu–Hf dates of drilled cores record the early prograde garnet growth, whereas the Lu–Hf dates of rim-rich fractions provide a maximum age for the end of garnet growth. The microsampling approach applied in this study can be broadly used in garnet-bearing rocks, even those without extremely large garnet crystals, in an attempt to retrieve the early metamorphic timing recorded in the older garnet cores. Given a proper selection of the drill-bit size and a detailed crystal size distribution analysis, the core of the mm-sized garnets in most metamorphic rocks can be dated, to yielding critical constraints on the early timing of metamorphism. This study provides new crucial constraints on the timing of the initial subduction (before *ca.* 469 Ma) and the ultimate closure (earlier than *ca.* 452 Ma) of the fossil Qilian oceanic basin.