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The fundamental tool for locating new examples of ultra-high pressure metamorphism: your eyes!

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In the space of just over 30 years ultra-high pressure (UHP) metamorphic rocks of continental origin, with characteristic indicators coesite and/or microdiamond, have gone from being an enigmatic, difficult to explain local feature of eclogite-bearing terranes to become an integral feature of numerous subduction-collision orogens the world over. The recognition of the over 100 km depths reached by crustal rocks as well as the extraordinary rates at which these rocks exhume are now accepted features of modern studies in geodynamics. Surprisingly, however, in the present-day scientific world of phenomenal computer power and seemingly unlimited automated analysis and data production, the investigation of UHP rocks, including the search for possible new coesite, microdiamond or minerals recording even deeper subduction (e.g. K-Hollandite or Stishovite) still requires skills in fieldwork and optical microscopy: aspects that are fast disappearing from modern earth science curricula. The search for coesite in the Himalaya was initiated by geothermobarometric calculations using published analyses for phengite-bearing eclogite to indicate rocks that had potentially experienced coesite-depth pressures. The prediction of UHP conditions was confimed after fieldwork in Pakistan unearthed fine-grained eclogites with multiple coesite inclusions (found optically and confirmed by micro-Raman) in omphacite. Soon after, the predicted UHP was also confirmed in the Indian Himalaya (Tso Morari). In the Variscan Orogenic belt, typified by high temperature metamorphism and granulites, UHP metamorphism was not to be expected. However, an important UHP indicator is the widespread presence of garnet peridotite with granulites of granitic composition. With a knowledge of the optical microstructures from well documented microdiamond samples it was possible to work systematically through existing thin section collections of the granulites and identify inclusions in garnet, kyanite and zircon of microdiamond, and its breakdown product graphite, by reflected light microscopy. Again, micro-Raman was used to confirm these finds. In a third example, from the Norwegian Western Gneiss Region, left-over eclogite zircons from a geochronology study were mounted and polished and tiny rounded inclusions investigated by micro-Raman. In this study it was much harder to find coesite inclusions as they appear very similar optically to quartz, apatite and other phases and in addition the connection to the primary rock texture is lost. In summary, preserved UHP minerals make up only a tiny fraction of material collected even from well documented UHP terranes. Skills in the field (you must collect the right rock!) and skill on the microscope (you must learn the features of UHP minerals from good standard samples in order to find the phases in new rocks) are still the most reliable and efficient way to expand our database of UHP samples and advance our knowledge of these exciting rocks.

Keywords: UHP metamorphism, coesite, microdiamond, Himalaya, Variscan