

RAMAN IMAGING OF NATURAL COESITE IN ARCHIVED PETROGRAPHIC THIN SECTIONS; VREDEFORT IMPACT STRUCTURE. John F. McHone¹, Marc Fries², Andrew Steele², ¹Dept. of Geological Sciences, Arizona State University PSF 1404, Tempe, AZ 85287-1404 <jmchone@hotmail.com>, ²Carnegie Institution of Washington, Geophysical Laboratory, 5251 Broad Branch Rd. NW, Washington, DC 20015 <m.fries@gl.ciw.edu>.

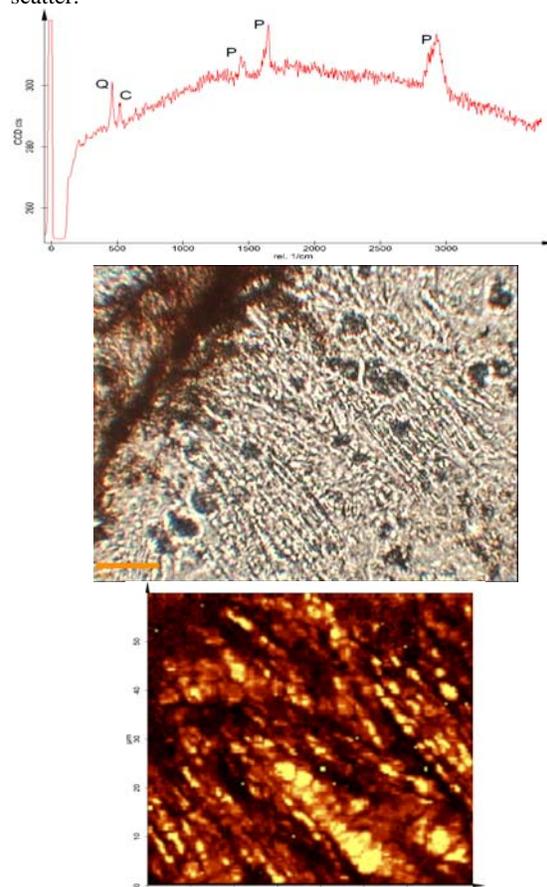
Introduction: Coesite and stishovite are minerals widely accepted as impact criteria when associated with suspected terrestrial impact structures. Both phases are pressure polymorphs of silica which form during shock metamorphism of quartz-rich target rocks. Their minute particle size and sparse distribution can make standard optical identification difficult for even the most skilled microscopist. The conventional method of detection requires partial HF digestion of whole rock samples, followed by X-ray diffraction analyses of successively concentrated acid residues. This procedure can be laborious and requires care with potentially dangerous reagents. Resulting data require skillful interpretation; diffraction lines can be masked by accessory minerals or by unexpected fluoride precipitates. In addition, bulk samples are usually completely destroyed.

A proposed impact origin for South Africa's Vredefort Dome was strengthened when Martini reported visible crystallites of both coesite and stishovite in optical thin sections cut from surrounding collar rocks [1]. Although his visual identification was supported with X-ray data, other workers found those results difficult to reproduce and his early report was met with some skepticism [2]. However, unambiguous mineral identifications were later accomplished using nondestructive Raman and NMR techniques [3,4].

We present in this report the successful use of imaging Raman spectroscopy to identify, and to map, coesite crystals in archived petrographic thin sections from Martini's original Vredefort discovery site

Experiment and Result A standard petrographic thin section prepared during early studies of shocked Vredefort quartzite was re-examined optically and an area was found which contained minute clusters of highly refractive needles within quartz grains bordering thin pseudotachylite veins [Ref 2 p. 292]. This site was then subjected analysis with Raman spectroscopy. Previous Raman studies [4] successfully detected coesite in a polished bulk chip of this same rock sample, but due to fluorescence of mounting polymer, internal reflections, and beam power control, no useful spectra were collected from thin sections. The device used in this study is a "WITec alpha" Confocal imager equipped with a 532 nm frequency doubled YAG green laser. Excitation energy is variable and is usually 9mw prior to entering the microscope optics. Maximum target scan size is 60 microns square, 130 pixels to a side, yielding 462 nm pixels. Integration time for image acquisition is 4 sec/pixel. Long working distance objective lenses allow laser energy to focus below

cover slip and mounting medium minimizing spurious backscatter.



Top: Raman Spectrum Q=quartz C=Coesite P=Mounting Polymer. **Middle:** Optical image of coesite cluster, Scale bar =20 microns. **Bottom:** Raman Image Map of Coesite (bright) from center of middle image.

Conclusion: Low power confocal Raman imaging permits precise, nondestructive mineral analysis of previously archived petrographic thin sections.

References: [1] Martini, J.E.J. (1978), *Nature* v. 272, pp. 715-717. [2] Martini, J.E.J. (1991). *Earth and Planetary Science Letters*, v. 103, pp. 285-300. [3] McHone, J.F. and Nieman, R.A. 1988 Vredefort Stishovite Confirmed Using Solid-State Silicon-29 Nuclear Magnetic Resonance *Meteoritics*, vol 23, p. 289) [4] Halvorson, K. McHone, J.F. 1992 Vredefort coesite confirmed with Raman spectroscopy (abstract). *Lunar and Planetary Science XXXIII*, pp. 477-478.