Advanced *in situ* chemical and structural analyses of new minerals representing extreme conditions

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Recent improvements in electron-beam nano-imaging and micro-chemical analysis in combination with novel tools for micrometer-scale structural analysis of minerals from synchrotron X-ray diffraction open a pathway towards *in situ* and non-destructive studies of mineral paragenesis that were previously not or barely accessible. Often mineral assemblies that represent extreme conditions also pose extreme challenges to analysis: very small size scale, complex matrix, minor amounts of material. Examples of such extreme, but also quite relevant environments are: a) High pressure shock-metamorphic minerals in meteorites and terrestrial impact sites, b) inclusions in diamonds from the deep mantle, c) ultra-refractory phases in Ca-Al-inlcusions from the solar nebula, d) presolar condensates. We show how a combination of electron-microscopy based high-resolution imaging and fully quantitative chemical analysis and qualitative structural identification with synchrotron-based structural and semi-quantitative chemical techniques establish a powerful tool for discovery and characterization of important and interesting new minerals on micron- to nano-size scales. Presented here are a few examples demonstrating this powerful approach.