Abstract Title: Fast identification of mineral inclusions in diamonds from known super-deep locality Juína, Brazil, reveal the inner workings of Earth's interior

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Minerals trapped inside diamonds act as messengers of the deep, avoiding alteration during their ascent in volcanic eruptions, bringing up information from the Earth's remote interior. While most diamonds originate from the upper 200 km of the mantle, some so called super-deep diamonds originate from depths >300 km, providing a glimpse into Earth's deep-mantle. Within the past five years, diamond inclusion research has made significant geochemical discoveries such as the first terrestrial ringwoodite, a high-pressure polymorph of olivine Mg2SiO4, found to contain 1.5 wt. % water structurally bound as hydroxyls (Pearson et al., 2014) and more recently the discovery of CaSiO3-perovskite (Nestola et al., 2018). In the past, the study of diamond inclusions has been largely limited to destructive techniques, which included the breaking of the diamond itself or polishing down to the inclusion. Destructive extraction techniques have the inherent risk of losing or altering the inclusions, which are usually under remnant pressure inside the diamond host (Angel et al., 2015). By studying mineral inclusions using non-destructive methods, properties like inclusion pressure, oxidation state, high pressure phases and volatile content remain. In-situ identification of mineral inclusions in diamond via non-destructive methods remains challenging as diamonds refractive index (n ~2.4) precludes typical identification methods. While some studies have utilized non-destructive methods using lab sources (Nestola et al., 2012), there remains a need for a method to quickly identify mircoinclusions in large suites of super-deep diamonds to obtain an insight into the composition of Earth's deep mantle.

We will present a detailed study on a set of rough diamonds from a known super-deep locality Juína, Brazil using a fast, high-throughput methodology we developed for the non-destructive, in-situ characterization of mineral inclusions using a combination of synchrotron X-ray microtomography, radiography and diffraction at the GeoSoilEnviro Center for Advanced Radiation Sources (GSECARS) sector of the Advanced Photon Source (Wenz et al., in press). With this new methodology we study diamonds in their rough state, thus preserving any high-pressure phases as properties like inclusion pressure and oxidation states. Such information provides both geochemical insight into the Earth's interior, as well as informs us on diamond formation processes. Every diamond is first imaged using the 13-BM-D synchrotron microtomography beamline at GSECARS. Once each inclusion's location is pinpointed the diamond then goes to the newly developed 2D radiography system at the 13-BM-C single crystal diffraction beamline, which hosts the Partnership for eXtreme Xtallography (PX^2) facility, a collaboration between University of Hawaii and GSECARS supported by the Consortium for

Materials Properties Research in the Earth Science (COMPRES). The results presented in this study demonstrate the high-throughput capability of the methodology as diffraction data was collected on 51 inclusions from Juina, Brazil within 72 total hours of beamtime.

References:

Angel, R. J., Alvaro, M., Nestola, F., & Mazzucchelli, M. L. (2015). *Russian Geology and Geophysics*, ***56*(1–2)**, 225–234.

Pearson, D. G., Brenker, F. E., Nestola, F., McNeill, J., Nasdala, L., Hutchison, M. T., Matveev, S., Mather, K., Silversmit, G., Schmitz, S., Vekemans, B. & Vincze, L. (2014). *Nature*, **507**, 221–224.

Nestola, F., Korolev, N., Kopylova, M., Rotiroti, N., Pearson, D.G., Pamato, M.G., Alvaro, M., Peruzzo, L., Gurney, J.J., Moore, A.E., & Davidson, J. (2018). *Nature*, **555**, 237–241.

Nestola, F., Merli, M., Nimis, P., Parisatto, M., Kopylova, M., Stefano, A. DE., Longo, M., Ziberna, L. & Manghnani, M. (2012). *European Journal of Mineralogy*, **24**, 599–606.

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