The importance of Mn-nodules on the sea floor during subduction for the formation of ophiolitic diamond

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Diamonds, native elements and unusual metal alloys from chromitites in ophiolites have been reported already almost 20 years ago (Bai et al., 2000). However, the genesis of these diamonds enclosed in chromite is still challenged. A major question is the origin of all the unusual elements and alloys recorded so far such as W, Co, Ta, CrFe, NiCu, AgAu, CoFeNi and most important Mn-Ni-Co alloys. Meanwhile, diamonds in chromite in ophiolites have been reported from several different locations on the planet (Tibet, Mongolia, Polar Urals, Turkey, Albania), which are separated from each other by long distances (Yang et al., 2014). There is one common feature observed in these diamonds, they usually contain small inclusions (from nanometre up to a few micrometre in size) of a Mn-Ni-Co alloy. The composition of the alloy is varying in diamond from different locations. These diamonds are natural diamonds that is demonstrated by the presence or coexistence of several additional nanoinclusions in diamond such as oxides, silicates and sulphides and selenides. Thinking about the genesis of these ophiolitic diamonds the question arises where all these strange elements and alloys come from? They are not typical Upper Mantle components. However, it is well known that Mn-nodules from the sea floor contain all these rare and unusual elements (Wegorzweski et al., 2015 and ref. therein). Subduction of the sea floor transports the nodules to a depth where melting of the nodules finally occurs. Depending on the Co-concentration melting of a Mn-Ni-Co ally will start at temperatures < 900°C with increasing Co-concentration at much lower temperature. Under local reducing conditions such Mn-Ni-Co alloy melt pools might exist in the subducted slab. The sea floor also contains plenty of organic material that could potentially supply the carbon necessary for the formation of diamond. Carbon rich fluids might react with the Mn-Ni-Co alloy melt, the melt acting as a catalyst to reduce the C-rich fluid to C. Carbon is dissolved in the alloy melt to a high amount depending on pressure and temperature. A change in PT during uplift then will result in the precipitation of solid carbon from the melt. If that happens in the diamond stability field diamond will precipitate. That process would explain the presence of such kind of Mn-Ni-Co alloy inclusions in diamond. Mn-nodules with their content of a wide variety of elements from the periodic system cannot only explain the unusual occurrence of diamond in chromitite in ophiolites but also the presence of other unusual elements and compounds. The details of the processes involved are not fully understood and they are subject of future investigations.

Bai, W.J., Robinson, P.T., Fang, Q., Hu, X-F., Zhou, M., (2000) Origin of PGE and base metal allloysin podifoem chromitites of he Luobusa ophiolite, southern Tiet. Canadian Mineralogist, 38, 585-598.

Wegorzewski, A.V., Kuhn, T., Dohrmann, R., Wirth, R., Grangeon, S. (2015) Mineralogical characterization of individual growth structures of Mn-nodules with different Ni+Cu content from the central Pacific Ocean. Amer. Min., 100, 2497-2508.

Yang, J., Meng, F., Xu.X, Robinson, P.T., Dilek, Y., Makeyev, A.B., Wirth, R., Wiedenbeck, M., Griffin, W.L., Cliff, J. (2014) Diamonds, native elements and metal alloys from chromitites of the Ray-Iz ophiolite of the Polar Urals. Gondwana Research, http://dx.doi.org/10.1016/j.gr.2014.07.004.

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