New minerals in the primary, deep-seated carbonatitic association

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In one of newly studied diamonds from the Juina area, Brazil, several new polymineral inclusions of the carbonatitic association were identified. The hosting diamond belongs, like most of the diamonds from this area, to the Deep Earth. The composite carbonate-halide-phosphate inclusion consists of magnesite, dolomite and mixed-anion phosphate micrograins along with nanograins of eitelite, halite, sylvite, phlogopite, spinel and pentlandite. The inclusion has a 'negative' shape, typical for syngenetic inclusions in diamond. The mineral assemblage comprising this inclusion belongs to the carbonate-chloride line of the primary, deep-seated carbonatitic association, which has been established among inclusions in diamond in our earlier works [1, 2]. Three new minerals for this association were identified in this inclusion: magnesite, eitelite and a mixed-anion phosphate, $Na_4Mg_3(PO_4)_2(P_2O_7)$. The presence of magnesite, within this new mineral association, provides evidence for its stability in the diamond stability field, which was earlier questioned; magnesite had been suggested to decompose with the formation of ferropericlase and diamond. Eitelite, $Na_2Mg(CO_3)_2$, has been identified previously in alkaline-carbonatitic rocks of the Khibini Massif, Kola Peninsula, Russia [3]. The mixed-anion phosphate, $Na_4Mg_3(PO_4)_2(P_2O_7)$, has not previously been observed in the natural environment before. This mineral contains an admixture of FeO (up to 6 at.%). In other carbonatitic inclusions, Fe-phosphate $Fe_2Fe_5(P_2O_7)_4$, and aluminium fluoride AlF_3 were identified. They were found in the natural environment for the first time as well. The carbonatitic inclusions most likely originated as a high-density fluid (HDF) micro-inclusions, encapsulated in diamond during its initial growth. Such inclusions are fully miscible under mantle conditions and subsequently crystallize as polyphase mineral inclusions, during ascent of diamond to the Earth's surface.

[1] Wirth, Kaminsky, Matsyuk & Schreiber, A. (2009). *Earth Planet. Sci. Lett.* **286**, 292-303. [2] Kaminsky, Wirth, Matsyuk, Schreiber & Thomas (2009) *Mineral. Mag.* **73**, 797-816. [3] Khomyakov, Sandomirskaya & Malinovskii (1980) Doklady **255**, 190-192.

Sampling a natural CO_2 reservoir, Green River, Utah

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We present the initial results from a scientific drilling project to recover core and high pressure fluid samples from a natural CO_2 reservoir near Green River, Utah. We use this as an analogue to investigate fluid-flow and CO_2-fluid-mineral interactions with caprocks and fault zones likely during anthropogenic storage of carbon dioxide

Diamond drilling of drill-hole CO_2W55, adjacent to the CO_2-degassing Little Grand normal fault, recovered core from two major CO_2 reservoirs in the Entrada and Navajo Sandstones, and from the intervening Carmel Formation caprock. The well encountered CO_2-charged fluids in the basal sandstones of the Entrada Sandstone, in open fractures in the footwall damage zone of the fault penetrating the Carmel Formation, and throughout the Navajo Sandstone. Downhole wireline fluid sampling to recover high-pressure CO_2-charged fluids during drilling, and analytical methods to measure their dissolved CO_2 content and pH on-site, are presented and discussed. Measurements of CO_2 concentrations, fluid chemistry and isotope ratios from the drill-hole fluid samples are used to constrain fluid-fluid mixing, fluid-rock reactions and dynamics of CO_2 migration within the fault damage zone. Fluid-mineral reactions predicted from fluid geochemistry are compared to petrological, mineralogical, geochemical and petrophysical measurements from the reservoir and caprock core, and the implications for reservoir alteration and caprock performance are discussed.

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