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Fracture and vein characterization of a crystalline basement reservoir, central Yemen

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The country of Yemen is located in the south-western part of the Arabian plate. The Pan-African basement found in western and central Yemen is highly deformed during the Proterozoic eon and is part of the Arabian-Nubian shield ANS (670-540Ma). This ANS is a result of the amalgamation of high-grade gneiss terranes and low-grade island arcs. The development of an extensive horst-and-graben system related to the breakup of Gondwana in the Mesozoic, has reactivated the Pan-African basement along NW-SE trending normal faults. As a result, younger Meosozoic marls, sandstones, clastics and limestones are unconformably overlying the basement. Some of these formations act as a source and/or reservoir for hydrocarbons. Due to fracturing of the basement, hydrocarbons have migrated horizontally into the basement, causing the crystalline basement to be a potential hydrocarbon reservoir. Unfortunately, little is known about the Pan-African basement in Central Yemen and due its potential as a reservoir, the deformation and oil migration history (with a main focus on the fracturing and veining history) of the basement is investigated in high detail.

Representative samples are taken from 2 different wells from the Habban Field reservoir, located approximately 320 ESE of Sana'a. These samples are analysed using e.g. the Optical Microscope, SEM, EDX and CL, but also by doing Rb-Sr age dating, isotope analysis and fluid inclusion analysis.

In well 1, the only lithology present is an altered gneiss with relative large (<5 cm diameter) multi-mineralic veins. In well 3, quartzite (top), gneiss (middle) and quartz porphyry's (middle) are intruded by a so called "younger" granitoid body (592.6±4.1Ma). All lithologies record polyphase systems of mineral veins. Pyrite and saddle dolomite in these veins have euhedral shapes, which means that they have grown in open cavities. Calcite is the youngest mineral in these veins, closing the vein and aborting the fluid flow. Fluid inclusions inside the calcite record homogenization temperatures (Th) of approximately 120°C with a maximum of 140°C. This is thought to be approximately equal to the calcite formation temperature. Also the euhedral saddle dolomite is thought to be formed at approximately these temperatures. Migration and precipitation of the vein systems represents an important process in the formation of the crystalline basement hydrocarbon reservoir.