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Thermal history of the Pan-African basement under the Jurassic Marib-Shabwa Basin, Yemen

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Pan-African tectonism within the Arabian Nubian Shield in Yemen is very poorly known. New drill-cores from the Marib-Shabwa Basin (Habban oil field) from central Yemen penetrated 600 m into the pre-Jurassic crystalline basement, providing a unique opportunity to extend our understanding of Pan-African events in Yemen. The cores were obtained some 80 km NE of the exposure limit of the Al Bayda Terrane, which lies SE of Sana'a. This terrane, which has no direct correlative in the ANS further north in Saudi Arabia, comprises deformed greenschist facies acid to basic volcanic rocks later witnessing acid to basic magmatism and has been previously interpreted as a Pan-African island arc complex with a basement component. Ophiolite fragments are common, both within the terrane and at its margins (sutures). To the north lies the Abas Gneiss Terrane and to the south the Al Mahfid Gneiss Terrane; both consist of older pre-Pan-African crystalline basement rocks. Geochemistry of a red, undeformed granite from the drill core indicates an A-type composition. LA-ICPMS U-Pb analysis of granite zircons gave two concordant age populations: 628.3 $\pm$ 3.1 Ma (large & small zircons) and 604.9 $\pm$ 2.0 Ma (intermediate sized zircons). The former age is interpreted as the time of crystallization, within the range of other A-type Younger Granites in the ANS, and the latter age as constraining lower temperature dissolution-reprecipitation of zircon, due to hydrothermal fluids or melt remobilization. Nd Tdm model ages for two granite samples from the drill core both gave ages of 1.24 Ga, within the range of the Al Bayda Terrane (1.2-2.5 Ga) and outside the range of the adjacent Palaeoproterozoic gneissic terranes (1.7-2.3 Ga, Abas Gneiss Terrane; 1.8-3.0 Ga, Al Mahfid Gneiss Terrane). Thus it seems certain that the Al Bayda Terrane extends at least 80 km to the NE of its present surface exposure. Rb-Sr biotite ages from the granite indicate closure through $\sim$300°C at 593 Ma, indicating fast cooling either as a result of near-surface conditions of emplacement or rapid exhumation. Zircon (U-Th)/He cooling ages ($\sim$180°C) are constrained to the Early Carboniferous. The youngest (Cenozoic) set of veins contain pyrite, (saddle) dolomite and calcite. Pyrite sulphur isotopes, the occurrence of saddle dolomite and calcite fluid inclusions provide strong evidence that the Pan-African basement was not re-heated to above 150°C after the last stage of deformation; this places some constraint on the thickness of the sedimentary cover that was deposited.