Salt domes of the United Arab Emirates: evidence for late Neoproterozoic sedimentation and rift volcanism in the northern Arabian-Nubian Shield

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Seven of the nine emergent salt domes of the UAE have been examined. They outcrop on the Arabian Gulf islands of Delma, Sir Bani Yas, Arzana, Qarnain, Zirku and Sir Bu N'Air, with one on-land salt dome at Jebal Dhanna. The salt domes range from about 1 km across (incomplete remnant of Qarnain) to over 6 km diameter (Delma) and form dissected hilly topography rising to about 140 m above sea-level (Zirku). The majority of the salt domes are single intrusions but two, Delma and Jebal Dhanna, appear to have multiple phases. The diapirs were emplaced penecontemporaneously with the Miocene country rocks, while evidence of recent localised halokinetic reactivation in small dome-like "salt blisters" is seen on a number of salt islands.

The rocks of the salt domes are termed the "Hormuz Complex", after the classic outcrops on Hormuz Island, Iran. The complex consists of highly altered breccia with a clay-rich matrix within which are embedded a large variety of exotic clasts ranging from the centimetre-scale to large rafts (mega-clasts) up to several hundreds of metres across. The original halite of the matrix has largely been dissolved to be replaced by anhydrite-gypsum, carbonate, Fe and Mn oxides and various clays and micas. The Hormuz breccia is extremely heterogeneous in terms of colour, grain size, alteration, mineralogy, internal structure, fabric and clast content. The heterogeneity is reflected in the landscape: rounded, deeply eroded multi-hued hills, with larger resistant clasts often forming chaotic upstanding blocks. Seismic sections across the domes show that they are near-vertical, pillar-shaped intrusions emanating from depths in excess of 10 km. The breccia may be massive or, particularly at the margins, strongly layered, with the fabric tending to dip centripetally away from the salt dome core. The entrained clasts thus provide a unique opportunity to examine the nature of the deeper levels of the crust of this part of Eastern Arabia. The clasts include igneous rocks, mainly volcanic, ranging in composition from basalt (but including gabbro and dolerite) to dacite, rhyolite and quartz porphyry. Intermediate compositions such as andesite are rare. A wide variety of sedimentary clasts are also present, including bedded grey foetid limestone, yellowish-brown dolomite and calcareous shale/siltstone, sandstone, sedimentary breccia and two examples of metasedimentary marble. Uniquely, Zirku Island has a semi-continuous carapace of turbiditic siltstones and sandstones (Zirku Formation). The compositional bimodality of the volcanic rocks suggests that they may have been generated during development of an extensional rift, with the Zirku Formation constituting syn-rift turbidites, and post-rift sedimentary fill represented by shallow-water carbonates and evaporites (original anhydrite and halite).

U-Pb zircon dating of four felsic igneous rocks from different salt domes shows them all to be Neoproterozoic (Ediacaran) in age, within error at c. 560 Ma. Dating of detrital zircons from a layered marble clast and a sample of Zirku Formation gave maximum depositional ages of c. 590 and 560 Ma respectively. The two detrital zircon spectra show major input of Neoproterozoic detritus with peaks at c. 600 and 800 Ma. Minor older peaks record detritus from late Mesoproterozoic, Palaeoproterozoic and Neoarchaean sources, probably derived from rocks known to form the core of the Arabian Shield hinterland and now exposed in southeast Saudi Arabia and Yemen. The Neoproterozoic peaks show major input from rocks of the Arabian Shield "basement" which must therefore lie beneath the Gulf coast region of the UAE. The Arabian Shield basement comprises distinct Western and Eastern blocks, separated by the Central Arabian Magnetic Anomaly. The Western Basement records the development of the Mozambique Ocean and volcanic arcs until about c. 620 Ma followed by closure, continent-multiple arc-continent collisional orogeny and the development of late pull-apart basins, escape tectonics, orogenic collapse and post-tectonic molasse clastic sedimentation in the Lower Palaeozoic. The Eastern Basement, exposed in Oman, stabilised earlier with metamorphic rocks at and granitoids dated between c. 824 and 726 Ma, followed by near-continuous sedimentation and volcanic activity through the Precambrian-Cambrian boundary and into the Palaeozoic. The detrital age spectra from the salt dome sedimentary clast samples show peaks characteristic of both Eastern (c. 750 Ma) and Western (c. 630 Ma) Arabian basement. This has the important implication that both blocks must have been juxtaposed by the time of deposition of the Zirku Formation (maximum age ca. 560 Ma) thus giving a minimum age constraint on the final collision between West and East Gondwana in the northern Arab-Nubian Shield along the East Africa-Antarctic Orogen, followed by rifting and volcanism on extended crust.