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Again: The enigma of the Persian salt dome inclusions

By AUGUSTO GANSSER¹⁾

Remarks to the Discussion by C. T. Talbot and R. F. Weinberg in *Eclogae geol. Helv.* 85/3:847–850 (1992).

I thank the authors, Talbot and Weinberg, for their stimulating discussion of my above mentioned paper. I agree that many of my informations are 35–40 years old and many areas have not been reinvestigated since. This concerns mainly some of the diapiric islands of the Persian Gulf while part of the Zagros, including its eastern end as well as the northern border of the Semnan basin have been investigated between 1960 and 1978. This included various reconnaissance flights over the world-famous Semnan diapirs (Jackson et al. 1990). These spectacular salt domes called for a detailed photogeological investigation during our courses at the Geological Institute of the ETH in Zürich.

In december 1990 I enjoyed visiting some Iranian salt domes together with Chris Talbot during the Iranian Diapir Symposium. I was actually amused reading in his discussion (p. 848): “C. T. can therefore attest to the veracity and beauty of Gansser’s field sketches”. Leaving the beauty out, I feel that the *veracity* of field informations and their reproduction should be the endeavour of a field-geologist and does not need to be particularly stressed.

And now to the enigmatic inclusions. I agree with C.T.s explanation for the concentric structures of some, but not many, salt domes. The enigma remains, however, to explain the transport of several km long, undisturbed rafts for nearly 8 km to the surface, well exposed in the Cha Benu dome, except one assumes a competent core of a cylindrical dome with a generally steeply dipping, waterlogged, highly mobile rim, represented by some Texas salt domes.

Highly controversial, and thus enigmatic, remains the famous group of Tertiary salt domes in the Semnan basin. Experimental results from the Ramberg Tectonic Laboratory in Uppsala and their application to the cluster of 50 salt diapirs are presented and discussed in the comprehensive volume of the Geological Society of America, Memoir 177 (Jackson et al. 1990). Both, Talbot and the writer are co-authors of this volume, Talbot from the experimental side, the writer from field investigations. By scaling down the complete section of the Semnan basin to 15 millimeters of carefully adjusted layers with corresponding density and viscosity contrasts, the centrifuge modeling produced beautiful mushroom diapirs, which most of the authors seem to recognize in the photogeological interpretations of the corresponding air photos, in spite of the difficulty in distinguishing gypsum from the Eocene salt and the generally much flatter dips in the

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highly colored layers of the Miocene salt (Fig. 1.20 and 1.21 in Memoir 177, 1990). Also the Eocene salt seems much more widespread than generally assumed. Similar to the Zagros, during their final emplacement the Semnan diapirs intruded into already existing structures, a fact not reproduced in the models. To Jovan Stoecklin, also co-author of the 177 Memoir, the striking contrast in style and intensity of deformation between the diapirs and the overburden is an absolutely fundamental field aspect of diapirism and the models have failed to reproduce this contrast. I fully agree with these personal remarks by Stoecklin. The deep and steep involvement of the overburden between the mushrooming model diapirs has still to be seen in the field.

Against the indiscriminate application of the mushroom models to the available field facts I have given various reasons, such as the vertical gypsum rim present in nearly all salt domes regardless of their erosive structural level. (Memoir 177, p. 70). For obvious reasons Talbot has to stand by his mushroom theories and did not particularly like my idea that the basic inclusions with their well preserved thermal contacts at their base (Fig. 15 in Gansser 1992) are not easily reconciled with assumed mushroom form of the corresponding diapir. Referring to his Fig. 1 (Talbot & Weinberg 1992), dome 22 is actually drowned in the Kavir and its rim is not exposed. We do not know its structural level. My enigmatic basic inclusions were also studied on domes 28 and 17, exposing different structural levels. However they occur in exactly the same way as in dome 22, all in a relative marginal position in relation to the dome surface. Assuming their transport in a mushroom dome, should their final emplacement not be inverted? Talbot cites (p. 848) "An enormous mass of trilobite-rich red Cambrian in the SE flank of the diapiric salt of Kuh-e namak (Dashti) appears to be inverted". This dome is however not mushroom shaped and produced a large salt glacier.

To test the mushroom-diapir model Chris Talbot rather optimistically proposes (p. 848) "For those with access to the Great Kavir it should be comparatively simple to apply the field test of the mushroom model implied in Figure 1 to some of the Kavir domes exposed at comparatively deep structural levels". And still more optimistic: "The internal macroscopic stratigraphy is clearly mushroom-shaped in air photographs of several of the well exposed salt domes in the Kavir". Without the application of geophysics, combined with drilling, we will never know for certain if the outstanding Semnan salt domes conform to the beautiful, experimentally produced mushrooms.

The Semnan problem is only one of my salt dome enigmas and certainly not the most important one. The main enigma remains the *origin* of some of the salt dome inclusions. This part of the story apparently does not interest Chris Talbot. It has received little attention in the salt dome literature. No problem exists for the Hormuz-type inclusions which are connected with the saline deposits. But what about the tonalites, gabbros and the migmatitic granite from Hengam island diapir, unknown in the late Precambrian and Phanerozoic sections of the Zagros ranges. They do crop out in the far-away Arabian shield! Even the Semnan basic inclusions are basaltic in an andesitic Eocene environment. And last but not least my recent discovery from the northernmost Semnan salt-dome 22 of a boulder of coarse grained pink nephelinite sitting on white Eocene salt, the biggest enigma of all.

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