MINDRE MEDDELELSER

AN INTERPRETATION OF THE QUATERNARY MORPHOLOGY IN THE PAARUP SALT DOME AREA

By

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Abstract

The most recent gravimetric survey in the Paarup salt dome area has shown that there is a close agreement between the topography and the gravimetric anomaly. On the basis of this agreement and the existence of some, apparently anomalous, Quaternary forms in the dome area, an interpretation of these forms from the point of view of salt tectonics is offered.

Most of the Danish salt diapirs are located back of the main Würm terminal moraines, i. e. those of the central portion of the Zechstein sedimentary basin in northern Jutland. Several structures, however, border closely onto the Main Stationary Line (ice-recession line C, see, e. g., HANSEN, 1965), and possibly only two are found clearly outside this line, that is in the country which was not covered by ice during the Würm glacial stage.

One of the diapirs bordering closely onto the Main Stationary Line in central Jutland is the Paarup salt dome. Its existence and an approximate location were known earlier (consult, e. g., SORGENFREI and BUCH, 1964). However, a very detailed gravimetric mapping of this area was done quite recently by LIND and RAMBERG (1968) who have kindly placed at this writer's disposal the results of their measurements (see the accompanying map). On this map the positive gravimetric anomaly indicating the cap rock effect over the salt dome is shown in relation to the morphology of the area.

As USSING (1903, 1907) showed, at this point a meltwater fan was built in front of the stationary ice (farther to the northwest this fan merges with the Karup outwash plain and, genetically, forms a part of that plain). Here, the meltwaters were apparently channelled through a lower lying area in the older, Riss landscape. Thus, a valley, some 3 to 4 km wide within the stretch under consideration, was formed. Its floor was covered by the meltwater deposits during a latter part of Würm, while the valley walls and the high ground bordering the valley on both sides have a Riss age.

The greater part of the Paarup salt dome lies at some depth beneath the valley floor, while only a smaller, northerly part is encountered under the Riss ground.

There exists a close agreement between the topographic contours and the isogals, especially in the strongest, central part of the anomaly. Regular and evenly spaced contours, which are more or less perpendicular to the valley walls in the northwestern part of the map, change their direction and become considerably steeper in the vicinity of the salt structure. Over the structure they »accommodate« themselves to the isogals. The height of the northerly valley wall remains approximately the same both outside and over the northern, marginal

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part of the structure, in spite of this apparent thickening of the meltwater deposits over the structure. Furthermore, the Riss terrain on this same side of the valley also attains the greatest heights over the structure.

The shallow stream valley which passes over the top of the anomaly, extending farther south than the wall of the main valley, is a topographic depression. It lacks its lowermost course and a normal outlet into the main valley.

Furthermore, it can be pointed out that the valley having its head at the ice border (and which was obviously formed in contact with ice), and which cut itself into the meltwater fan, parallels closely the southwest side of the dome. It curves around its southern »tip«, as if avoiding an obstacle in its course. This valley may be considered contemporaneous with (the oldest stage of ?) the Karup River valley, which cut its course across the Karup outwash plain farther to the north.

On the basis of the mentioned, apparently anomalous, morphological features in the Paarup salt dome area and the close agreement between the topography and the gravimetric anomaly, the assumption can be made that upward movements in the salt dome, which deformed the Pleistocene deposits, took place. In the following an explanation based on this assumption is offered.

The youngest Pleistocene deposits affected by such movements are those that make up the valley floor. It would be reasonable to suppose, however, that the uplift was occurring simultaneously with the meltwater deposition and the formation of the valley floor, so that during the time the above mentioned valley was cutting itself into the meltwater fan, a topographic high over the salt dome had already existed.

The youngest form affected by the uplift is the shallow valley which extends over the top of the anomaly. This valley does not extend up to the ice border. It does not possess an angular transverse profile, which is characteristic for valleys formed under the periglacial climatic conditions. In general, its shape is »softer« than that of a typical periglacial valley. This valley was probably formed sometime during the late glacial time, once after the ice had retreated some distance from the Main Stationary Line. Due either to an accelerated rate of uplift, or possibly because the supply of water available became too small, the lower course of this valley was »erased« by the uplift and its upper part cut off, so that that part presently forms a depression. Thus, the uplift was taking place during at least some part of the late glacial time. Whether the movement continued also during the Holocene, or, in other words, how much of the existing relief over the salt dome might be due to the postglacial salt tectonics, is not possible to say at the present stage of investigation.

Theoretically, an uplift over a salt structure might be due to:

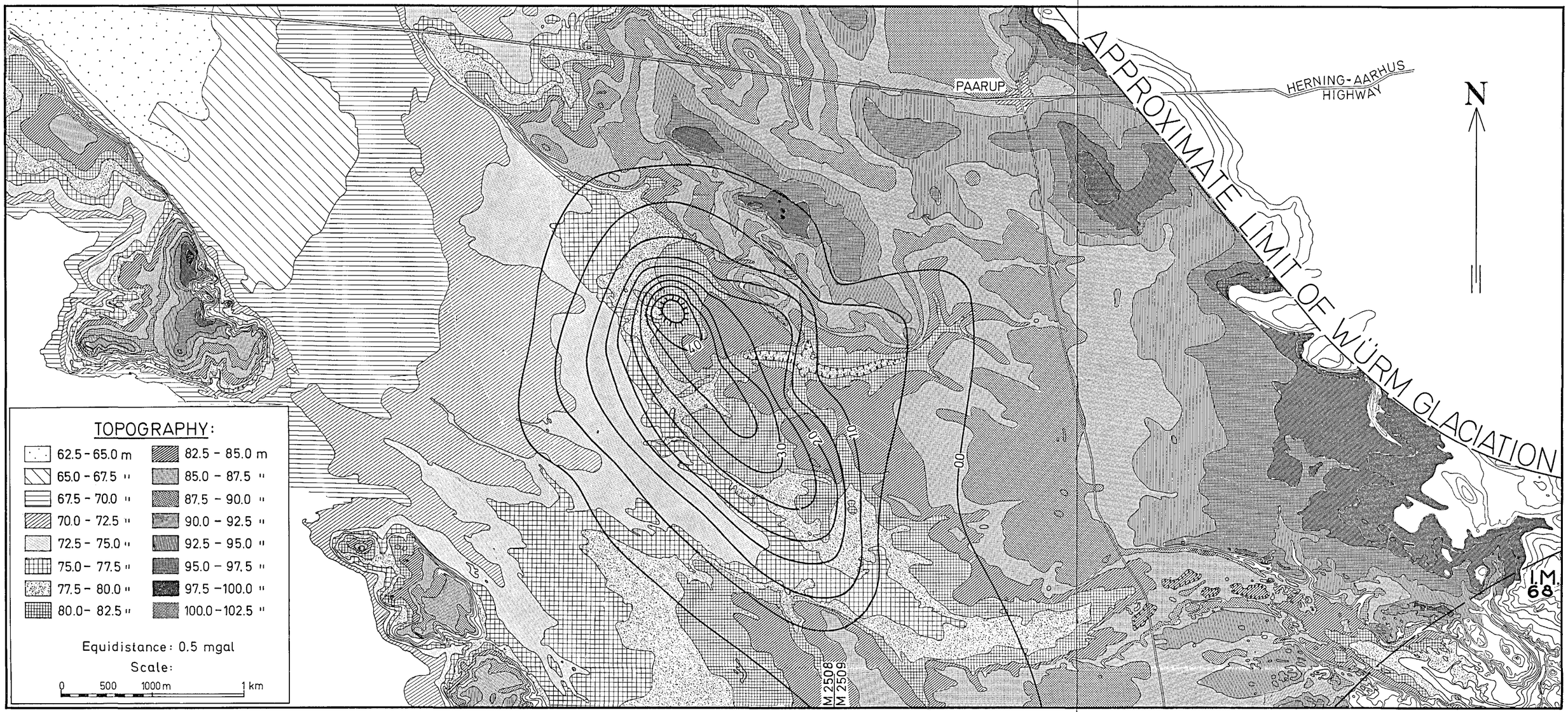
1) upward flow of salt and its actual rise towards the surface.
2) differential solution of salts at the salt mirror and a consequent increase in volume of the less soluble materials (cap rock) above the salt mirror.
3) increase in volume within the existing cap rock, due mainly to the hydration of anhydrite to gypsum within the zone of the circulating ground water.

On the basis of the available data (the close agreement between the topography and the positive anomaly indicating the cap rock effect, and the very high positive values obtained) it seems that in the case of the Paarup salt dome the considered uplift was produced mainly by the processes involving an increase in volume of the cap rock.

A detailed geological study of this area, possibly combined with a boring which would disclose the thickness of the Quaternary deposits as well as the age of the pre-Quaternary rocks over the top of the salt dome, is necessary before a definite conclusion can be reached as to the validity of the above offered interpretation.

Dansk sammendrag

Fornylig har LIND og RAMBERG (1968) udført en meget detailleret gravimetrisk undersøgelse i Paarup saltstruktur området (se artikel i dette hefte, s. 248). Det vedlagte kort viser den positive anomali, som angiver »cap rock effect« over strukturen.


PAARUP
HERNING-AARHUS HIGHWAY
N
APPROXIMATE LIMIT OF WÜRM GLACIATION
I.M. 68
M 2508
M 2509
4.0
3.0
2.0
1.0
0.0
TOPOGRAPHY:
62.5 - 65.0 m
65.0 - 67.5 "
67.5 - 70.0 "
70.0 - 72.5 "
72.5 - 75.0 "
75.0 - 77.5 "
77.5 - 80.0 "
80.0 - 82.5 "
82.5 - 85.0 m
85.0 - 87.5 "
87.5 - 90.0 "
90.0 - 92.5 "
92.5 - 95.0 "
95.0 - 97.5 "
97.5 -100.0 "
100.0 -102.5 "
Equidistance: 0.5 mgal
Scale:
0 500 1000 m 1 km

Paarup saltstruktur ligger umiddelbart foran den på kortet angivne, omtrentlige beliggenhed for »hovedopholdslinien« (efter USSING, 1903, 1907). Den brede dal, hvis bund er opbygget af Würm smeltevandsaflejringer, danner genetisk set en del af den mod nord liggende Karup hedeslette. De højere partier på begge sider af dalen og selve dalens vægge stammer fra næstsidste nedisning (Riss). Den største del af saltstrukturen ligger under dalens bund, medens dens mindre (nordlige) del findes under Riss-terrænet.

Man finder en tydelig overensstemmelse mellem anomalien og topografien. Især over den stærkeste, centrale del af anomalien falder de topografiske kurver ganske nøje sammen med de gravimetriske isogals.

Den dal, som har skåret sig ind i smeltevandsaflejringer, og hvis øverste del grænser mod isen, danner en kurve ved strukturens sydlige »spids« og grænser i sit lavere løb tæt op mod strukturen og er parallel med den.

Den dal, som strækker sig over toppen af anomalien, og krydser hoveddalens nordlige væg, er en topografisk depression.

Riss-terrænet langs den nordlige side af hoveddalen er højest netop over saltstrukturen.

Ud fra disse morfologiske træk samt ud fra den herover nævnte lighed mellem topografien og den gravimetriske anomali kan man antage, at opadgående vertikale bevægelser i saltstrukturen har fundet sted, hvorved Pleistocene aflejringer er blevet deformeret.

Sådan en deformation synes at have foregået samtidig med smeltevandsaflejringen, d. v. s. dannelsen af bunden af den brede hoveddal, således at en topografisk høj over toppen af strukturen allerede eksisterede, da den dal, som har skåret sig ind i disse aflejringer, dannedes.

Den yngste påvirkede form ville være den dal, som strækker sig over toppen af anomalien. Dens nedre del blev »udvisket« af bevægelsen, og resten af dalen danner nu en depression.

En detailleret geologisk kartering, muligvis kombineret med en boring, som ville afsløre dybden til »cap rock« og mægtigheden af de kvartære samt prækvartære bjergarter, anses for nødvendig, før den her fremlagte tolkning kan akcepteres definitivt.

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