Prom. Nr. 3768

Die Geologie des Gebietes nördlich des Kandevan-Passes (Zentral-Elburz), Iran

VON DER

EIDGENÖSSISCHEN TECHNISCHEN HOCHSCHULE IN ZÜRICH

ZUR ERLANGUNG

DER WÜRDE EINES DOKTORS DER NATURWISSENSCHAFTEN

GENEHMIGTE

PROMOTIONSARBEIT

VORGELEGT VON

Martin Glaus
dipl. Ing. Geologe ETH
von Guggisberg (BE)

Referent: Herr Prof. Dr. A. Gansser
Korreferent: Herr Prof. Dr. R. Trümpy

Zürich 1965
Offsetdruck: Schmidberger & Müller

SUMMARY

The present work contains the geological description of a part of the northern Elburz. The investegated area lies in the central sector of this chain, north of the Kandevan tunnel, covering about 1000 km^2 east and mainly west of the road leading to Chalus (see figure 1). Crossing the Elburz from Karaj to Chalus in the north five main stratigraphical and structural units can be distinguished, of which the Tertiary Central Zone and the Paleozoic-Mesozoic Central Range are both described here.

The oldest rocks of the whole Elburz chain occur within the regional uplift of the Alam Kuh Group and are intruded by granites and quartz monzonites forming the high peaks of the Alam Kuh (4840 m) and the Takht-é-Suleiman (4520 m). The metamorphic rocks of this region, of which more particulars are to be found in a paper by GANSSER and HUBER (1962), indicate eugeosynclinal depositing conditions strongly contrasting with the Paleozoic, Mesozoic and Tertiary miogeosynclinal shelf type deposits of the Paleozoic-Mesozoic Central Range and the Elburz in general.

About 800 m of green, subordinate wine red, silty slates enclosing frequent intercalations of grey to brown-yellow, crystalline dolomites and (especially towards the top of the formation) of reddish-green, quartzitic sandstones represent the oldest sediments in the region east to the Alam Kuh uplift. These slates which are called Kahar formation (type locality Kuh-é-Kahar south of upper Taleghan valley) show an elevated percentage of sericite suggesting a slight, beginning metamorphism of an argillaceous matrix. Fossils are completely lacking but judging by the stratigraphical position a late pre-Cambrian age can be assumed. Above the Kahar formation follows with a sharp and conformable but perhaps heterochronous contact the Soltanieh formation consisting of light, white to grey-yellow, thickly bedded dolomites which contain in their lower part dark slates, sandy shales, brownish dolomites and siliceous limestones known under the name of Chapoghlu shale member. Measuring up to 600 m the Soltanieh formation, with its pure carbonate rocks, corresponds to a marked break in the monotonous late pre-Cambrian to Middle Cambrian sedimentation of prevailing sandy to silty and argillaceous, multicoloured rocks. Fine sandy and silty shales, in the lower part with layers of dolomites, overlie the Soltanieh formation, namely the Barut formation (with dolomites) and the Zaigun formation (without dolomites). The Middle Cambrian Lalun formation

concludes the first series of unfossiliferous pre-Cambrian and Lower Cambrian sedimentary units. This formation, formerly wrongly compared with the Devonian Old Red Sandstone, can be subdivided into a lower quartzitic part (200 m), a middle unit of red sandy shales with conglomerates and subordinate intercalations of sandstones (60 m) and finally a conspicuous white top quartzite (25 m). Especially interesting are the shales of the middle Lalun formation which display various casts and marks as well as mudcracks indicating a very shallow and partially even nonmarine environment. Of uncertain, perhaps fluvial, origin are the conglomeratic layers which carry pebbles of devitrified rhyolites and multicoloured, dense quartzites in a sandy matrix.

An enormous stratigraphical gap seperates the Lalun formation from the Lower Carboniferous Mobarak formation which lies paraconformably on the older sediments. Only locally are dolomites, sandy shales, sandstones and pink marly limestones of the Lashkerak formation to be found. The marly limestones and marls yielded a rich fauna (see p. 41) which permitted the dating of the Lashkerak formation as Lower Ordovician. It ist thought that the striking changes in thickness of the Lashkerak formation (from 0 up to nearly 200 m) are not so much due to secondary erosion as to primarily irregular sedimentation. In the whole northern Iran Ordovician is represented only by the few exposures of Lashkerak formation, and the paleo-geography of this epoch is still very enigmatic.

After a prolonged emersion, the sea invaded the northern Elburz again in Lower Carboniferous times with the predominately carbonatic Mobarak formation (500 m). Of the numerous fauna gathered (see p. 49) especially the corals proved helpful in dating the formation; the bulk is Viséan, the transgression having taken place during the Tournaisian. The relations between the Mobarak formation and the Geirud formation (Devonian to Lower Permian) of the southern Elburz are still incompletely understood (see figure 8). This also applies to the type Mobarak section northeast of Teheran which shows considerable changes in facies compared to its northern equivalent. A well developed Permian sequence comprising three more formations follows paraconformably on the Lower Carboniferous, the transgression being marked by a not very distinct basal conglomerate. Of Lower Permian age is the Dorud formation comprehending a sandy to shaly lower part, a cyclic sedimentation of partly oolitic Fusulinid limestones and subordinate sandy as well as mrly layers and finally an upper unit of polychrome sandy shales and white,

quartzitic sandstones. The Dorud limestones furnished a great number of Linoproductus cora (ORB.) together with a well preserved fauna of Fusulinids (Pseudoschwagerinida, Triticites and others) which unfortunately have not yet been determined. The lower Dorud formation is mainly sandy to quartzitic in the south but becomes much more limey in the northern field area where the rhythmic alternation of limestones with sandy and marly beds starts already at the lower limit of the formation. Thus the transgression seems to have come from the north. Agreeing with this assumption is the fact that the formation becomes considerably reduced in thickness towards the southeastern Elburz, measuring nearly 400 m near the Chalus road, 100-200 m in the Karaj- and Djajerud valleys and 0-100 m in the mountains between Ab-é-Ali and Firuzkuh. Real marine conditiones were established again in Middle Permian times, being documented by the 250 m of dark, cherty limestones forming the Ruteh formation. Its fauna is rather sparse (see p. 64) and the lower as well as the upper age limit of the formation is not yet satisfactorly fixed. The limestone complex may however be roughly compared to the Chihsia limestone (Parafusulina Zone). Towards the southern Elburz it seems to become younger as its higher parts are probably already equivalent to the Maokou limestone (Neoschwagerina Zone). The Ruteh formation is conformably overlain by the Nesen formation which a stratigraphical gap probably divides into a lower and an upper member. The lower unit consists of calcareous sandstones overlain by slightly marly, black limestones. The uppermost limestone banks seem still to belong to the Parafusulina Zone judging by one sample of Hayasakaia sp. A more precise dating could be expected from the beautiful Fusulinids occuring in the same horizons but they still await determination. The upper Nesen formation is a calcareous to marly deposit striking by its extremely abundant Indo-Armenic brachiopod fauna. Especially characteristic is a bed about 30 m below the top of the formation carrying numerous Oldhaminid brachiopods (see p. 69 f.). Above this bed the macrofauna disappears making place to a sparse but typical Fusulinid fauna (Reichelina sp., Staffella sp.). There is no doubt that the upper Nesen formation represents Upper to Uppermost Permian and may be compared to the Middle and Upper Productus limestone, the Djulfa beds and to the Lopingian of China. With the latter 55 % of the determined species are in common. The Upper Permian sea was probably restricted to the northern Elburz where it formed a narrow strip roughly parallel to the actual chain communicating perhaps with the Djulfa region in the west. So far the formation is only known from the mountains north of the Kandevan tunnel and the upper Nur valley. A further exposure was discovered on the road

leading to Amol about 29 km to the south of this town. In southwesterly direction the formation shows a very rapid decrease in thickness, the lower Nesen formation disappearing completely and the upper member at least partially. One can measure 230 m of Upper Permian north of the upper Nur valley, but only 45 m a few kilometres to the southwest in the vicinity of the Chalus road.

The boundary Paleozoic/Mesozoic is not very conspicuous. Slightly oolitic limestones of the Triassic Elikah formation overlie with a sharp an apparently conformable contact the dark, siliceous Nesen limestones and, in contrast to other places in the Elburz, absolutely no indications suggesting an interruption in sedimentation are discernible. Platy to marly, greenish hieroglyphic limestones (calcaires vermiculés) together with peculiar breccias and conspicuous red, hematitic gastropod limestones form the lower Elikah formation and are followed by clear, well bedded dolomites which form imposing cliffs. Although very poor in fossils, the lower Elikah formation probably can be attributed to the Skythian, whereas the age of the upper dolomitic part is still uncertain as organic remains are completely absent. Strong epeirogenetic movements coupled with a regional emergence are responsible for an accentuated pre-Liassic relief on which the Liassic Shemshak formation lies with a disconformable overlap. A real angular disconformity, however, is nowhere to be seen. The name Shemshak formation applies to a very thick Rhaeto-Liassic unit of grey to olive-green, locally coal-bearing sandstones and shales of near-shore to paralic origin. The soft, valley-forming sediments are extremely widespread and are developed throughout the greater part of Persia. Except for a doubtful schuppen-like zone immediately northeast to the Kandevan tunnel Jurassic, Cretaceous and Lower Eocene is missing in the mapped area. This is probably due to erosion and partially also to non- deposition.

Tertiary rocks are absent in the Paleozoic-Mesozoic Central Range but are, on the other hand, very well developed in the Tertiary Central Zone. The volcanic and pyroclastic Karaj formation (Eocene) can be divided in a lower unit of dark limestones, marls, tuffaceous sandstones and well bedded green tuffs comparable to the Lower Shale Member of the Karaj valley-section and an upper, strongly volcanic unit (Middle Tuff Member) of tuffs, andesitic flows and agglomerates. Neither the lower nor the upper stratigraphical limit of the formation are anywhere to be seen. It is believed that the important Kandevan thrust fault, which seperates the Tertiary Central Zone from

the Paleozoic-Mesozoic Central Range, corresponds more or less to the northern shore of the Eocene sea and that the Central Range was already strongly elevated and emerged by this time.

A strong folding phase of the Alpine orogeny set in during the late Eocene or early Oligocene. Advancing from the west a last marine invasion led to the formation of several small and narrow strips of sea which just reached the Karaj-Chalus road in the east. In these was deposited the Oligo-Miocene Red formation which covers with a sharp angular unconformity the underlying Karaj formation. The Oligo-Miocene series begins with a basal limestone member containing a shallow water fauna of small foraminifers (mainly Miliolids and several other genera) which proved to be indeterminable in thin slides. Above the limestones follows a thick alternation of red sandstones rich in volcanic débris grading into and alternating with coarse red conglomerates carrying almost exclusively andesitic pebbles cemented by a sandy matrix. It is still uncertain whether the Red formation should be correlated with the Upper Red- or the Lower Red formation of the Central Iranian basin. The fact that andesitic flows still seem to occur within the lower part of the formation points to the latter of the two possibilities. A more detailed study of the microfauna will probably settle the question.

The different formations up to the Lower Mesozoic are cut by a great number of dykes which seem to be especially plentiful in the pre-Carboniferous sediments. Quartz-porphyries, different sorts of diabases, lamprophyres, diorites and questionable olivine basalts have been recognised and described. Marked volcanic activities are further documented by Middle Permian (between Ruteh- and Nesen formation) and pre-Liassic (between Elikah- and Shemshak formation) volcanic and pyroclastic deposits. The first consists of diabasic flows alternating with layers of lapilli tuffs and tuffitic marls very rich in hematite which are thought to have been laid down in a terrestrial environment. The pre-Liassic magmatic phase was solely eruptive and formed more or less agglomeratic tuffs, volcanic breccias and carbonate-rich palagonite tuffs. A short description of the Karaj formation concludes the petrographical chapter. The flows of this formation are all andesitic with phenocrysts of common augite, labradorite and a hemicrystalline to pilotaxitic matrix. Very exceptional is an irregular (intrusive ?) body of devitrified dacites occuring near the Kandevan thrust fault. The tuffs normally occur as glass-bearing crystal tuffs and contain plagioclase attributable to two groups of different acidity (e.g.34-45 %

and 47-57 % anorthite). This could have been brought about by the mixture of material originating from two regional magmatic centres slightly differing in the acidity of the erupted and extruded material.

The strong orogenetic phases in Eocene to Oligocene and again in late Miocene to Plio-Pleistocene resulted in a strong folding and thrusting of the sediments in the Tertiary Central Zone. The beds are everywhere dipping to the north, forming very narrow synclines and anticlines with axes generally dipping to the southeast. All the structures except one anticline of the Lower Shale Member along the Kandevan thrust fault and one big syncline of the Red formation have more or less been overthrust one upon another and form now a succession of tilelike, south-vergent packets in which anticlinal and synclinal zones are difficult to distinguish. A very different tectonic pattern is shown by the Central Range, where practically no folding but strong faulting and block faulting is present. A persistent fault direction strikes NW-SE and is accompanied by a second, diagonal direction striking SW-NE. The faults are mostly perpendicular or north-dipping (Kandevan thrust fault). A remarkable exception to this rule was found in the north near Dozd-é-Band where along a south-dipping plane the whole Precambrian and Paleozoic sequence is overthrust on a northern unit of Paleozoic rocks. The fact that the faulting system which is intensified near the main Kandevan thrust fault does not continue into the Tertiary Central Zone indicates an old, at least pre-Eocene, establishement of the fault pattern which was only reactivated during the following paroxysms. Thus the Central Range assumed a block folding-like position and differs from its eastern equivalent (described by STÖCKLIN 1959) which reveals intense folding apparently caused by north-directed movments.