STRUCTURAL INVESTIGATION OF GULEMAN (ELAZIĞ) OPHIOLITE

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ABSTRACT. — Guleman ophiolite is one of the ultramafic-mafic units located in the Tertiary thrust zone in southeastern Turkey. Guleman ophiolite mainly consist of tectonite and cumulate rocks, harzburgite with some dunite and chromitite bands makes the tectonite group of rocks. Cumulate rocks of dunite, wherlite-clinopyroxenite, gabbro overlie the tectonites with an angular discordance. These rock units indicate that «Guleman ophiolite» may be considered as an incomplete ophiolite with some rock units mising. The map pattern of Guleman ophiolite suggest a fold structure aligned with the regional structural setting. Orientation of the boundaries between the rock units and the layering in the cumulates fit reasonably well with this pattern. On the other hand compositional layering and foliation present in the tectonites do not quite fit into this established pattern. Because of this; structures present in the tectonites are considered to be related to different phase of deformation. Here the details of these structures given and some related problems are discussed.

INTRODUCTION

Ultramafic-mafic rocks which outcrop in Guleman area, 50 km east of Elazığ, is defined as an incomplete ophiolite suite broken by tectonic slicing and named as «the Guleman ophiolite» (Özkan, 1982a). The Guleman ophiolite is one of the ophiolite masses of the Tertiary nappe zone (Perinsek, 1979; Sungurlu, 1979) in Southeast Anatolia.

The Guleman ophiolite has been investigated from the point of view that the emplacement of these rocks in the regional stratigraphy (Ercan et al., 1970; Aykulu, 1971; Erdoğan, 1977; Özkaya; 1978; Perinçek and Çelikdemir, 1979) and much more for the intention of studying economic geology in the area. Most recently the author investigated the petrology, structure and the arrangement of the ophiolite Suite (Özkan, 1982a).

In this paper, the results of the structural investigations of the Guleman ophiolite, will be elaborated.

GENERAL GEOLOGICAL SETTING OF THE OPHIOLITE

The ophiolite rocks in the study area, overlain transgressively by sedimentary rocks Upper Maestrichtian-Lower Eocene Hazar and. Middle Eocene Maden complex. The ophiolite rocks together with the sedimentary units which are overlying them are found as tectonic slices pushed over the Lower Miocene age Lice formation sediments in the Arabian platform (Rigo de Righi and Cortesini, 1964; Erdoğan, 1977; Perinçek, 1978; Özkaya, 1978, Perinçek and Çelikdemir, 1979, Özkan, 1982). Base of this ophiolite slice, is in the nature of tectonic melange which also contains blocks of sedimentary and metamorphic rocks. In the tectonic melange which outcrops around Guleman, Kündikan and Yukarı Bahru villages, the ophiolite rocks are highly serpentinized, mylonitized and have lost their primary formation character completely.

In other areas, despite local disturbances due to strong tectonic effects, in general the stratigraphy is in a recognizable state. By detailed mapping and generalizing the primary relationships in the outcrops that have not been affected technically, the stratigraphical order in Figure 1 was determined.

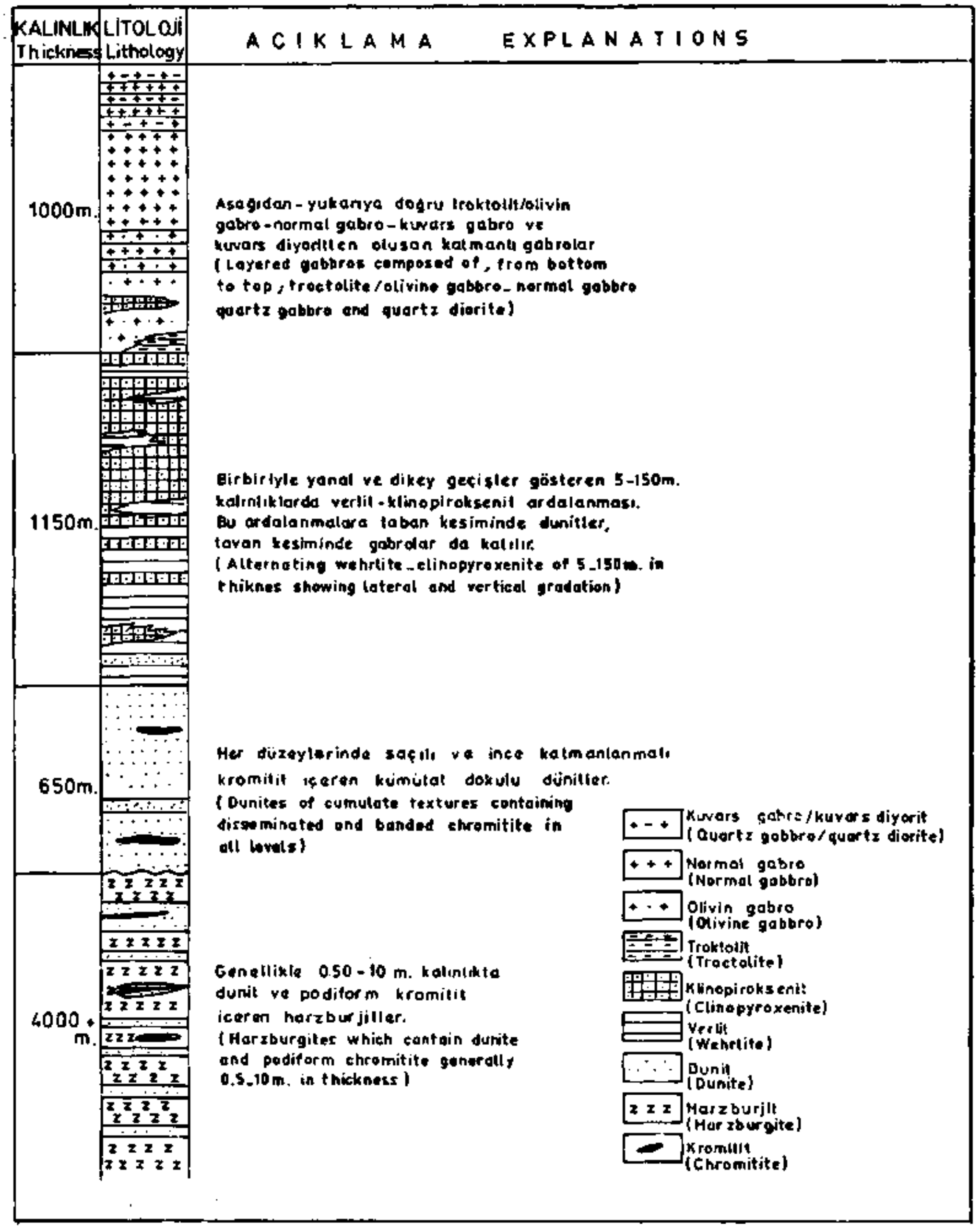

Fig. 1 - Generalized columnar section of Guleman ophiolite.

As seen in the figure, at the base ultramafic tectonite which is made up of dunite-harzburgite sequence is seen. Dunites cover lesser extend than harzburgites.

The ultramafid tectonites noticeably show plastic deformation and recrystallization structures and textures.

A sequence of rock types that start witli ckinite and extend to quartz gabbro/diorite overlie the tectonites. These rock units that show typical structures and textures of crystal settling are named as cumulates.

The cumulates are mapped as three subunits that show transitional zones at their contacts. They are (1) dunite, (2) wherlite-clinopyroxenite, (3) gabbros.

As shown in the map (Fig. 2) the tectonite-cumulate contact is observed faulted everywhere. However, interpreting all the data available, it is feasible to think that the contact may be an angular discontinuity as against being sheared (Özkan, 1982b).

Stratigraphy and petrology of the ophiolite have been discussed in detail in another publication (Özkan, 1982b).

STRUCTURAL INVESTIGATION

The detailed mapping of the Guleman ophiolite, by dividing it into subunits, brought out an interesting structural feature. The geological map of the Guleman ophiolite show a folded structure with an axis in E-W direction (Fig. 2 and 3). However, taking into account that all the contacts are faulted and along the contacts wedge shaped tectonic structures, these cannot be regarded as plastic folding. The field observations show that the Guleman ophiolite has been subjected to regional compressional stresses and under the stress it was forced to folding and the weak planes of contacts due to shear stresses are faulted to form wedge shaped structures. As a result of these faulting, wedging and folding, an assymetrical map pattern has developed where different thicknesses on the sides of the fold axis, an incomplete sequence is observed.

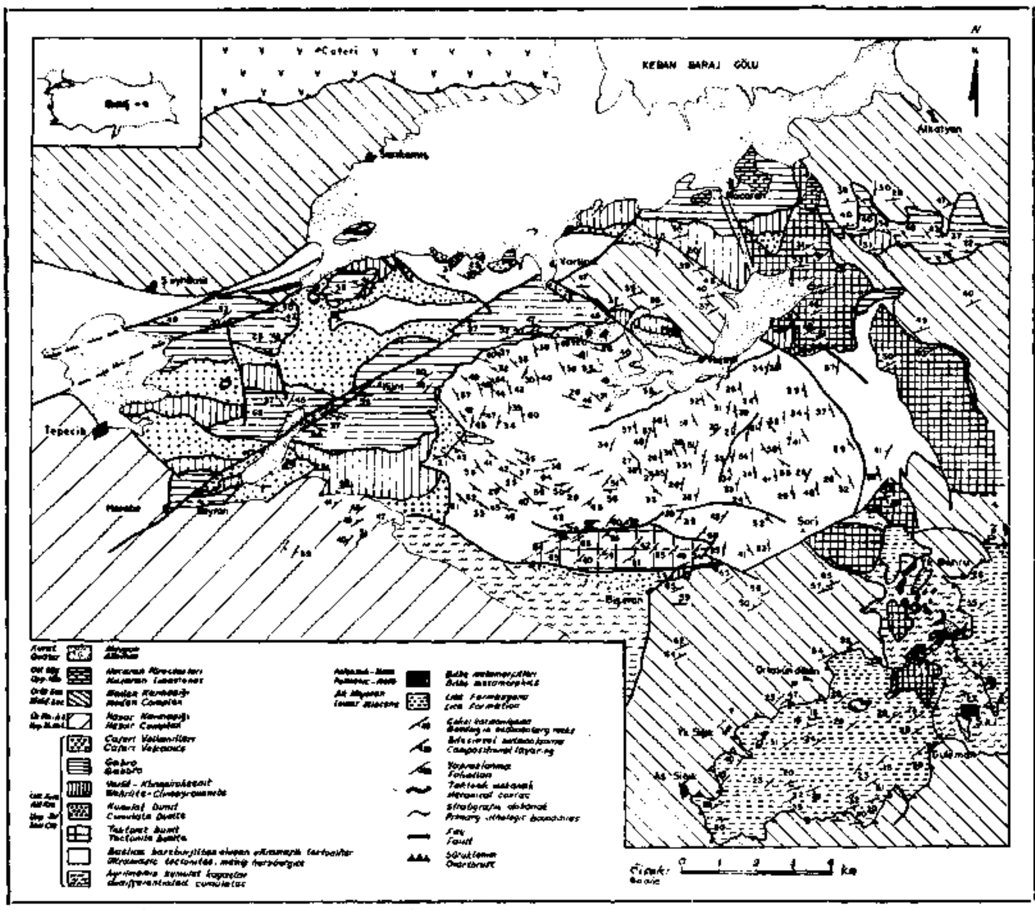

Fig. 2 - Geological map of Guleman ophiolite.

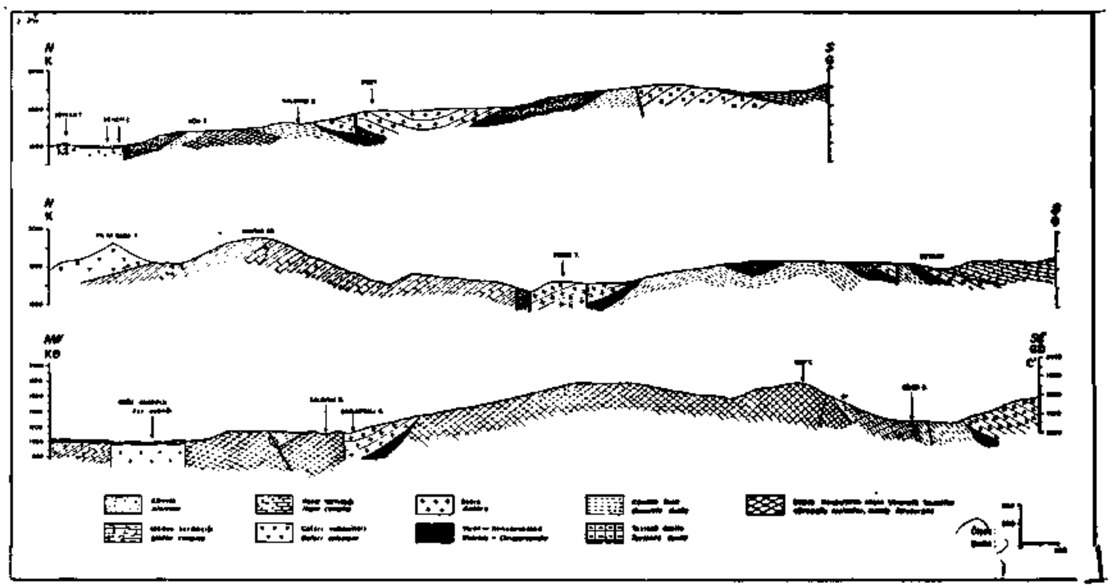

Fig. 3 - Cross sections of Guleman ophiolite.

The strike and dip directions of the contacts as observed on the topography are in agreement with the above structures deduced from the map pattern.

Magmatic stratification in the cumulates are also comformable with the above structure (Fig. 4). Some deviations observed are within the limits of a disturbed folding mechanism.

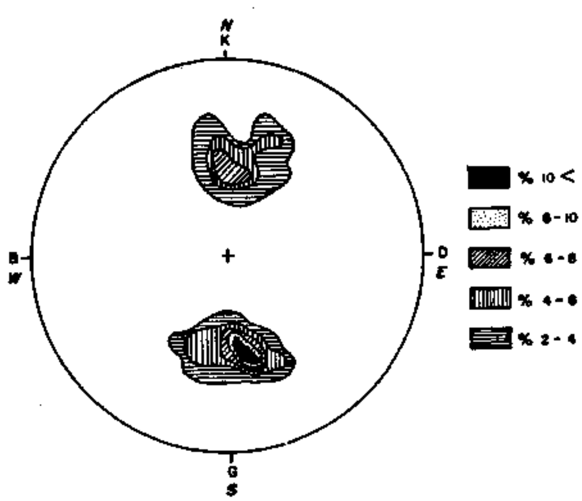

Fig. 4 - Schmidt diagram prepared from strike and dip values of magmatic layering in cumulates (257 measurements).

On the other hand, the situation of the inner structural elements of the tectonites is completely unrelated to the above structure and show a complicated pattern (Fig. 5 and 6).

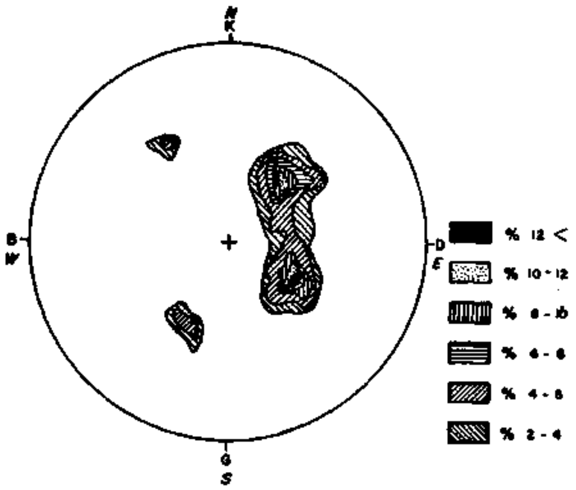

Fig. 5 - Schmidt diagram prepared from strike and dip values of compositional layering in tectonites (368 measurements).

It should be emphasised that the meaning of the term «complexity» used in this paper must not be interpreted beyond the auther's intentions. Here, by the expression «structural complexity» it is meant that the inner structural elements of the tectonites not showing a uniform or orderly pattern (for example, conforming in any manner to a folding) in the outcrop area. In fact the Guleman ophiolite is one of the most orderly one in its class. As explained below, there are large areas (up to a 75 km^2 each) that show uniform structures. As explained in (Engin et al., 1983) in these areas showing orderly structures chromite ores extend 1-2 km.

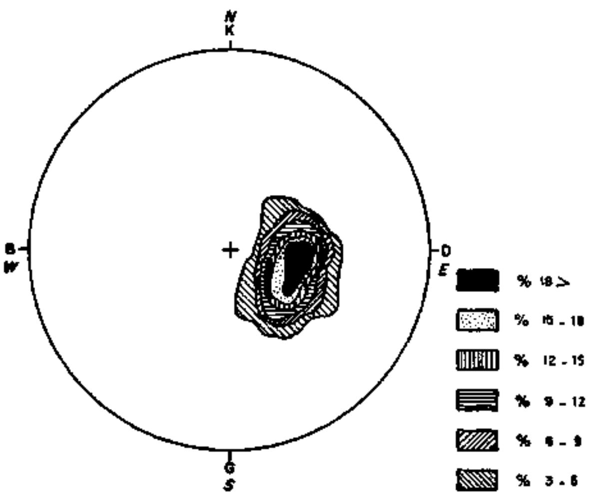

Fig. 6 - Schmidt diagram prepared from strike and dip values of foliations in tectonites (110 measurements).

In fact, the map pattern of the strike and dip values of compositional layering in the tectonites allows us to subdivide the exposure area into four regions which show uniform pattern in themselves. Structural data obtained from the compositional layering, transfered onto the schmidt net projection (Fig. 5) shows five groupings of dips/strikes that are related to the five regions. Relating to the map pattern of dip/strike values. 290*/32 is the mean value around Gevenli T., Taşlı T., Büyük Sori Dağı, Dola T.; 147/49 is around Kef T., Ayı T., Kapin T.; 222/34 is around Kavga T., Kuş T., Birek T. and 028/38 is around Çirik T., Kortuğun T., Pindamın Sr.

It may be taken that the strike and dip values for foliation show similar distribution. Because the observations and measurements made on the outcrops, the foliation in ultramafic tectonites conform with the structural layering. Eventhough, the Schmidt projection prepared from the measurements on the foliation show only one grouping, this result is due to the fact that the most of the data on the foliation was collected from one area where the compositional layering presented a uniform character (Dola T., Büyük Sori Dağı).

On the other hand, it is not evident that the complexity of the inner structure of the tectonites is the result ofthe deformation stage during and/or after the emplacement ofthe ophiolite. It is thought that this is a completely different process. Perhaps, one may suspect that during the emplacement, brittle ophiolite rocks are fractured and formed a complex mosaic. In the field evidences that support this idea have been observed.

The strike dip values between the subregions mentioned above change suddenly along linear boundaries. Eventhough this may be an indication of a fault line, field observations offer no real evidence for this. On the contrary along big fault lines there is no significant change in the strike/dip values. So there must be a meaning for the change ofstrike/dip values along lines that are not interpreted as faults. Further more, during the deformation, as expected, the tectonites showing similar mechanical response and deforming in accordence with the folding mechanism. The mentioned structural complexity of the tectonites cannot be explained easily.

It is concluded that all these, as mentioned above, the linear boundaries between the regions that have uniform inner structures must be the result of the plastic shearings during the plastic deformation of the rocks. This thought brings us to the conclusion that the complex structures in tectonites may have developed during the deformation in the mantle.

If the above interpretation on the inner structure of the tectonites, is correct (if the complexity is related to the plastic flow in the mantle), It does not agree with the model proposed by Juteau et al. (1977).

According to Juteau et al. (1977) in a model representing the structure ofoceanic crust and the upper mantle around oceanic ridge that inner mantle plastic flow will be simple and in accordance with the plate movement away from the ridge. They, further, propose that by bringing the attitude of the magmatic layering in the cumulates to the horizontal (their primary attitude) all the other structural elements would be transformed to their original attitude in the ridge. Hence by calculating statistical orientation of foliation and compositional layering, mineral lineations, shearing in olivine and orthopyroxenes, situation and the orientation of paleo-ridge would be determined.

However, it is interesting that the structural pattern observed in the Guleman tectonites show that the structural relationships developed by plastic flow in the mantle is not so simple as- suggested by Juteau et al. (1977). Considering the situation in Guleman, apart from the dislocations during the obduction of ophiolite, relationship between the structural elements of the tectonites is so complex that the model cannot be applied by plastic shearings with in the mantle. Eventhough in limited number of ophiolite outcrops present simple structures suitable for the model, this kind of local data may produce erroneous results.

CONCLUSIONS

Finally various structures observed in the Guleman ophiolite, show that it has been subjected to deformations that followed one another in different tectonic settings.

Some of these, as observed in the tectonites are the foliation and lineation, plastic foldings and plastic shearings developed during the plastic deformations in the mantle.

The structures developed at this stage are so complex that it was not possible to determine under which pattern of stress they were developed.

This preliminary deformation stage is followed by the deformations caused by plate movements during and after the emplacement. Folding and faulting and fracturing of the Guleman ophiolite developed at this stage.

From the geometry of the structures developed during the second stage (from the E-W orientation of the fold axis and orientation of the fractures in Fig. 7) the stress direction in the area is in N-S direction. Considering the age of the emplacement of the ophiolite, during the Upper Cretaceous and after, all the deformation stages were under the stresses in the N-S direction. Hence, the plate movements that kept the region under stress since the Upper Cretaceous have remained unchanged.

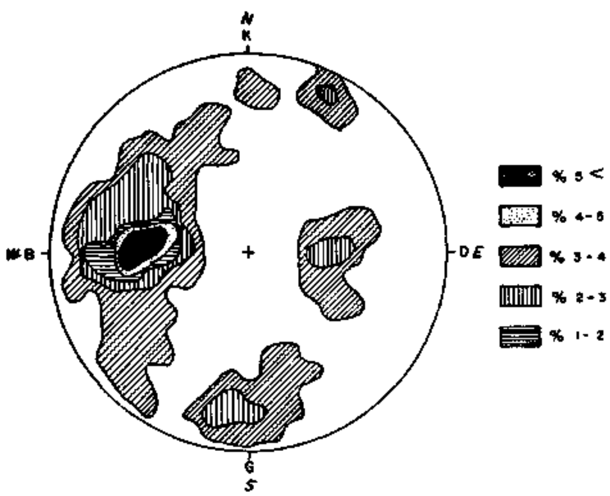

Fig. 7 - Schmidt diagram related to faults and joint in Guleman group (465 measurements).

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