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NEW ASPECTS ON THE TECTONIC OF THE ALPS AND THE APENNINES REVEALED BY ERTS-1 DATA

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The alpine region is one of the most complicated and best investigated part of the world. Therefore, it is very interesting to compare the ground truth with data revealed by ERTS-1 imageries. One would expect that no new features could be detected.

Figure 1 shows the geographical situation and the main petrographical units together with the most important fractures (after TOLLMANN, 1969). One notices many diagonally crossed fractures in the northern Calcareous Alps, a few structures in the molasse and few lineaments in the crystalline central Alps revealed by geologic field work.

On the other hand fig. 2 gives a composite view of what can be detected by using ERTS-1 imageries. There are much more structures to be seen than ever could be shown on a map with a comparative scale.

Considering the information more separately, fig. 3 shows - generalized - the largest and most striking lineaments in this area.

This kind of information, connections between shearing systems of more than regional importance, could never be revealed before. Only in one case, an European geologist (Prof. TRÜMPI, Zürich, Switzerland) supposed a connection of faults from the Loisach - Zugspitze (Germany) to the Bergell massive (Italy) by field evidence.

These large lineaments are not influenced by any nappe systems or specific rock properties. Therefore, they can be assumed to have been formed during a very late stage of the alpine orogeny. There appearence in pairs, their straight course, give strong evidence for shearing movement. The unit cube in the upper part of fig. 3 shows the sense of movement to be expected on the shear planes, assuming N - S as the direction of highest compression. The drawn directions are conform to field data. NE - SW is the main direction of left-lateral faults, NW - SE is the direction of right-lateral faults. This means that the whole Alpine body has been affected by a compressing force even after nappe transport and that the locally detected strike-slip faults belong to a huge and extended shearing system.

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This system is not limited to the Alpine body, but it extends to its molasse foreland. In this foreland with its low resistent young sediments, faults and fractures are difficult to detect and they are mostly revealed by geophysical data or oil well drillings. But ERTS-1 imageries show the pattern of different lineaments very clearly. These lineaments often end at the Alpine margin or the folded part of the molasse. This folded part of the molasse probably buffered the stress down to the amount in which a shearing system could develop instead of folding or nappe overthrusts. The knowledge of the tectonic evolution and the structural pattern of the molasse may once become important for petroleum prospecting.

In the same manner, one can find faults parallel to the long axis of the Alps, which are supposed to be dip-slip faults. A good example for this type of fault is the Inn-valley fault which separates Mesozoic limestone from paleozoic rocks or from the crystalline complexes. Similar conditions occur at the Periadriatic suture which, running E-W, is limited in the West, where the NE - SW striking transverse fault "Judicarien linie" cuts it off. But on ERTS-1 images one can detect a prolongation of the suture, which goes on as a lineament for a long distance. This means, that this lineament if probably still active. Precise nivellment measurements have been testing this for some years and the first results confirm this idea.

There are some reasons, why a considerable amount of these shearing faults and lineaments could remain undetected by geologists. The first reason is their dimension. They are too extended, their course is often along broad valleys, so that the scale of the arial photographs is too large for detecting regularities. The second reason is that the displacement is mostly small and their effect is often limited to a mechanical disarrangement of zones which are scarcely exposed.

Finally the Alpine geologists are used to work in a very complicated area; the field relations between adjacent petrographical units are obscured by nappe transport, overthrusts, rapid changing in the sedimentary facies and local tectonics, so that a superregional synthesis and analysis is difficult. ERTS-1 data can, therefore, be extremely useful for supporting field work.

In fig. 4 only bedding and the distinguishable main rock units are shown together with some glacial moraines. In addition to the general strike of bedding, one can often find the direction and roughly the amount of dip when the bedding planes dissect a mountain relief.

In the crystalline series of the central Alps the parallel drainage pattern sometimes shows the direction of schistosity. New information is brought for the molasse, where even in the part which is considered to be horizontally bedded, the trace of bedding planes can be observed, but ground check has not yet been done.

In summary it can be said that ERTS-1 data make it possible to reveal new geological knowledge even in a very well investigated area. New lineaments and faults can be detected and connections between faults can be seen. In some cases tectonic hypotheses can be examined or improved, still active tectonic can be detected. Especially in the molasse, having low resistent rocks and partly covered with glacial material, an entirely still unknown tectonic pattern could be recognized.

ERTS-1 imageries can contribute to increase our knowledge of the Alps and its foreland and help for better understanding the complicated tectonics of the Alps and its relation to the molasse foredeep. Of economic importance for petroleum research, is the structure of the Molasse.

Similar to the evaluation of the tectonic of the Alps, the main structural features could also be recognized in the Apennin range of the Italian peninsula.

Locally known fault systems, predominately strike-slip faults and horst structures, could first be traced over more than a hundred kilometers. Accordinaly it was possible to supplement the known fault systems. Two main directions of lineaments may be recognized. The one striking NW-SE belongs to fold axes and to dip-slip faults, producing some horst structures. The Italian volcanoes are lined up in the same direction. The other group of lineaments strikes about E-W and represents strike-slip faults.

This work, however, has not yet been finished.

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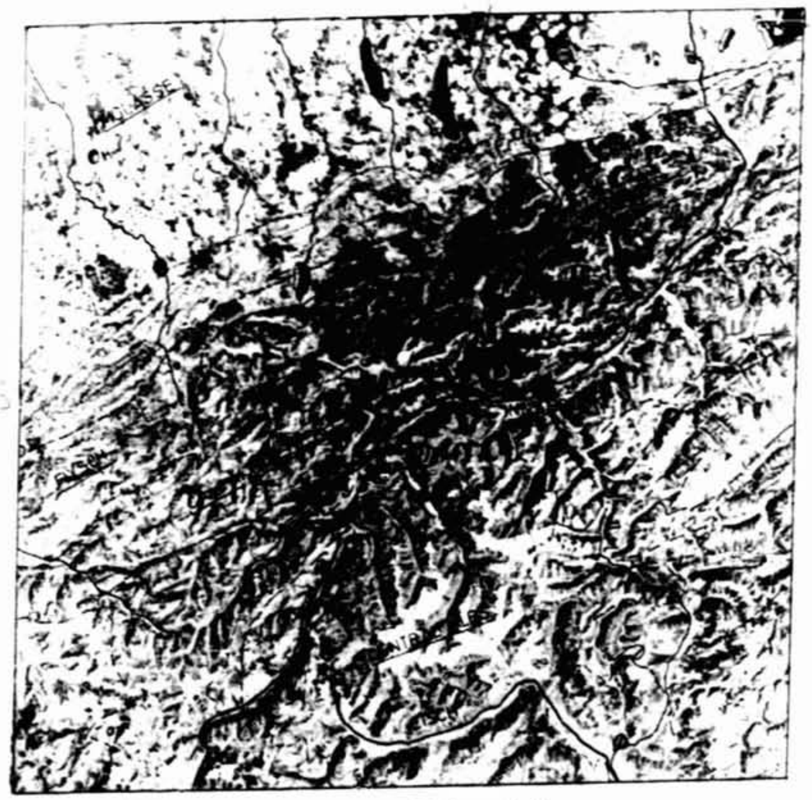

Figure 1

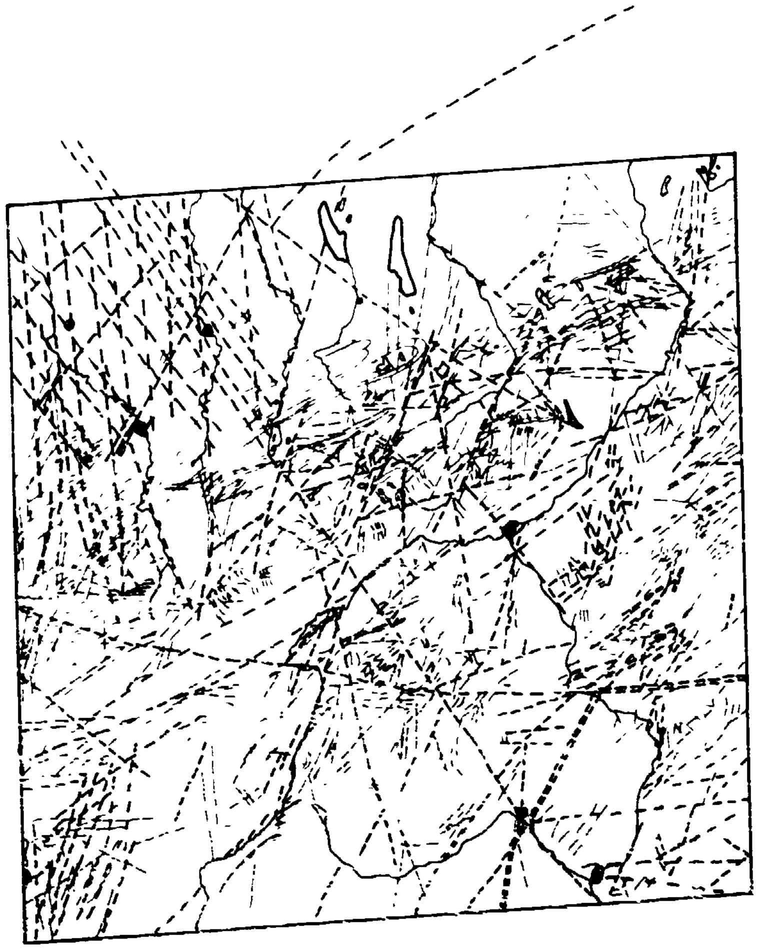

Figure 2

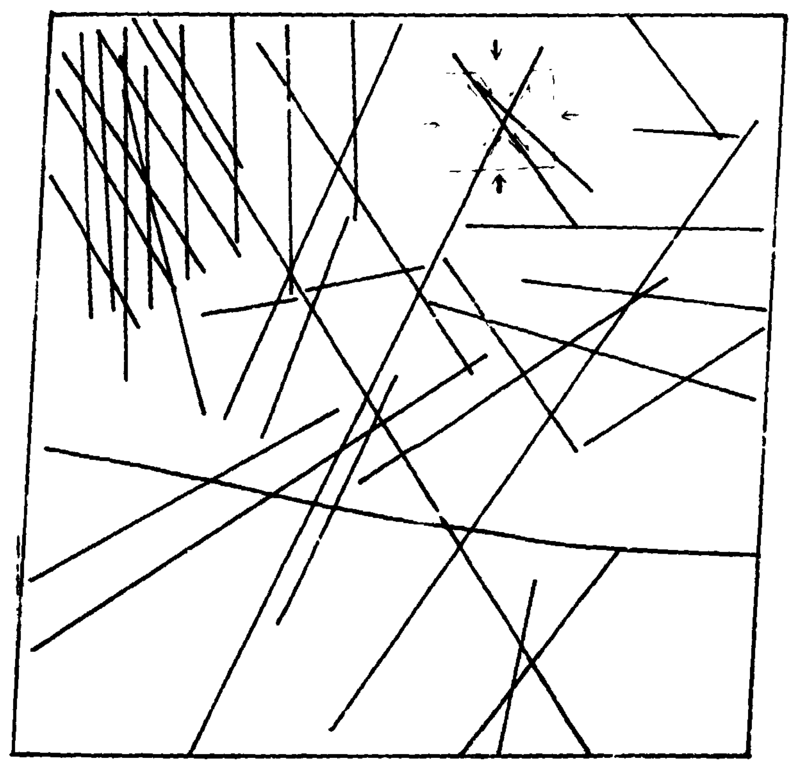

Figure 3

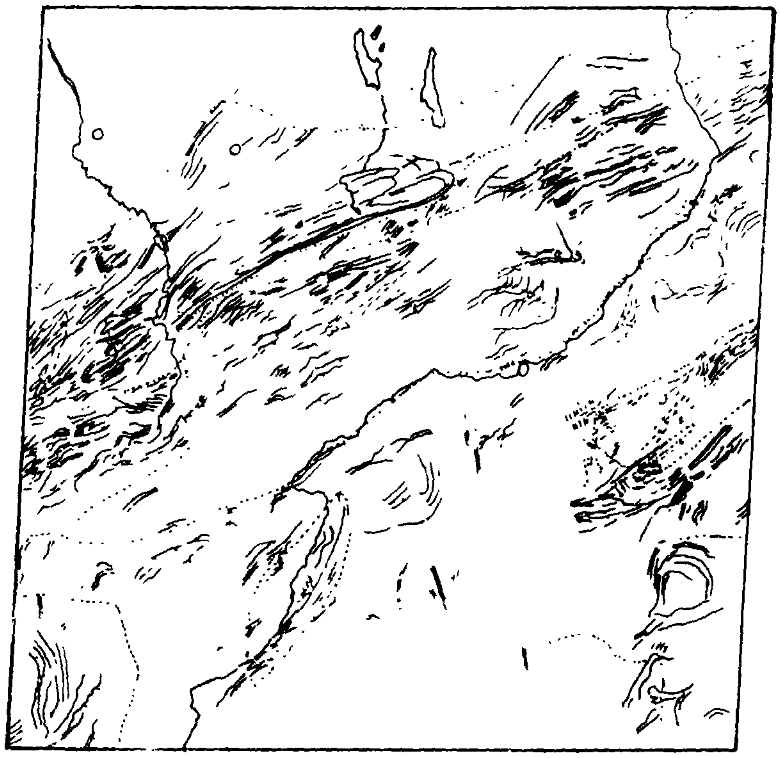

Figure 4

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