Türkiye ile İskoçya Arasında bir Mukayese

W'. J. Mc Callien[1]

Özet: Jeoloji ilminin kurucularından adedilen Hutton, geçmişi bu günkü hadiselerin müşahadesinden istidlal edebiliriz, demişti. Memleketim olan İskoçya'daki eski yanardağların etüdünden, Hutton nazariyesinin tersine olarak, bugünü öğreniriz. İskoçya'nın başlıca fizyografik formları Kaledonyen hareketleri ile ilgili olduğu halde jeoloji bakımından daha genç olan Türkiyede daha henüz sona ermiş olan Alp hareketleri bu hususta mühim amil olmakdadır. Tersiyerde İskoçya'da volkanlar o devrin bariz mirasları olduğu halde Türkiye'de iltivalar ve faylar en ön safta gelmektedir.

İskoçya'da Tersiyer bürkanî merkezleri, şimalî İrlanda ve batı İskoçya'dan İzlanda ve Greenland'a kadar inkişaf eden kuzey Atlantik kıtasının bazaltlarını vermiştir. Bu bazalt pilatosunun çökmesile bu günkü Atlantik denizi meydana gelmiştir. Teşekkülü zamanında bu bazalt kıtası iki buçuk milyon kilometre kare bir saha işgal etmiş olmalıdır. Bu bürkanî sahraların kalınlığı beş altı yüz metre etrafındadır. Büyük entrüzyon merkezleri bu günkü ölmüş volkanlarda olmakla beraber bunlar birbirine bağlıdırlar. İki türlü entrüzyon şekli kabul edilmekdedir. Bunlardan (ring-dykes) tabir edilenlerde entrüzyonlar bir merkezi olan daireler şeklinde, plütonik jenesli ve merkezden dışarı doğru sert bir zaviye ile meylederler. (Cone-sheets) tabir edilen diğer çeşit entrüzyonlar ise bir merkezden içeri doğru 45 derecelik bir zaviye ile meylederler.

Türkiye jeologları bu memleketin (transversal) lerile ünsiyet peyda etmişlerdir. İstanbul Ünivesitesinden Profesör Parajas tesbit ettiği yedi (Transversal) i bir bültenle yayınlamıştır. İran'da da Schroeder on kadar (Transversal) ayırt etmiş bulunmaktadır. Gerek İran ve gerek Türkiye'deki (Transversal) lerin menşelerinin bir olduğu ve birinin izahının diğerine şamil olacağı pek az kimse tarafından inkâr edilebilir,

Bu (Transversal) lerin Arap Blokuna nazaran aldıkları dağılış şeklile batı İskoçya'daki (cone-sheet) lerin tasavvur edilen yeraltı magma hazne-

---

(1) Ankara Üniversitesi, Jeoloji Profesörü.

sine nisbetle aldıkları formlar arasında göze çarpan bir benzerlik müşahede edilmektedir. Dr. Anderson İskoçya'daki (ring-dyke) ve (cone-sheet) lerin aldıkları mahrutî formları, 10 kilometre kadar derinde olduğu tahmin edilen magma mahzeninden gelen tazyik neticesi hasıl olan dairevî çatlaklardan yükselen magma ile izah etmektedir. Magma tazyiki yukarı doğru şakulî, Arap bloku ise kuzeye doğru ufkî tazyik yaparak İskoçya'da (ring-dyke) ve (cone-sheets) leri, Türkiye ve İranda'da işaret edilen (Transversal) leri meydana getirmiştir.

Scotland and Turkey - a Comperison

W. J. McCallien[1]

Introduction

JAMES HUTTON (1726-l797), a Scotsman famous in the annals of Geology, has been considered by many as ihe founder of modern geology. It was Hutton who was responsible for the concept that the present is the key to the past. This concept may not be literally true in its entirety, but no one can deny that it has been successfully applied to the solition of many geological problems: Hutton's theory was first published in 1785 in a communication to the Royal Society of Edinburgh. It was republished in two volumes in 1895. Hutton's views did not become well known, however, until 1802, when John Playfair, Professor of Mathematics in Edinburgh University, published a volume called Illustrations of the Huttonian Theory of the Earth. PIayfair's aim was to explain Hutton's views in a clearer manner than Hutton himself had done. Playfair was highly successful in this, and the theory as we know it, is largely due to his writings.

Being a Scot, it seems fitting that in my first talk to the new Geological Society of Turkey, I should say something about certain aspects of geological research in Scotland and Turkey which seem to bear comparison. I shall restrict my remarks, however, to one phenomenon in each country. The phenomena chosen are of much more than local interest, and the study of the one may throw light on the study of the other.

I shall take this opportunity of discussing the Scottish phen¬omena in a little detail. Like my Turkish colleagues I also suffer from the extreme difficulty of getting literature, and the probIems that I shall discuss may be new to some of you.

The geological interpretation of the structure of ancient volcanoes in Scotland, as the detailed studies of the officers of the Geologieal Survey, is such that it could nol very well be made on modern or geologically recent

---

(1) Professor of Geology, Ankara University.

volcanoes. In other words these studies illustrate the opposite of Hutton's famous thesis, the interpretation of the present from studies of the past.

The essential features of Scotland are very largely controlled by Caledonian mountain structures, although the country has undergone many vicissitudes since the far-off days when these mountains were formed. Turkey, on the otherhand, is geologically a comparatively new country in which the controlling features are due to Alpine movements, wich are only now slowly dying down.

In both countries we find Tertiary volcanoes. In Scotland, these volcanoes are the most important relies of the period, and because they have been highly eroded and dissected, and their stumps carefully studied, they have acquired an importance of the first magnitude in geological science. In Turkey, on the other hand, first place must be given in the make-up of the country to the Tertiary fold mountains. Let us, therefore, discuss and, if possible compare, Tertiary volcanoes in Scotland with Tertiary mountains in Turkey. It seems a very unorthodox comparison but let us make the attempt.

The Tertiary Igneous Rocks of Scotland[1]

The Tertiary igneous centres of western Scotland are remnants of great North Atlantic, of Thulean, province of igneous activity. The basaltic floods of the Thulean region probably covered the area extending from northern Ireland and western Scot-land through the Faroes, Iceland, and Jan Mayen. to Greenland. It was the breaking up of this great basaltic plateau which gave rise to the north Atlantic ocean. The original area covered by the basalt flows must have been of the order of a million square miles.

Although the igneous rocks themselves are of great interest and have been studied in detail in most of the fragments now preserved, it is with the forms of some of the igneous bodies that we are specially concerned here. The thicknesses of the laves average a few thousand feet, and they are asso-

---

1 - Based on the writings of Dr. J. E. Richey, especially in British Regional Geology: The Tertiary Volcanic Districts, Geological Survey, 1935.

ciated with a profusion of dykes believed by some to represent the infillings of fissure eruptions in many cases. These represent the first phase of the activity and were followed by a local phase characterized by the existence of explosion volcanoes of great size. These events were largely due to the uprising of acid magma and they were accompanied, both before and after, by the intrusion of great plutonic masses. Finally, the activity ended with another regional phase marked by the injection of more dykes.

The great intrusive complexes marking the sites of extinct volcaneous are situated in the Hebridean islands of Skye, Rum, Mull, and Arran and on the mainland of Scotland in Ardnamurchan, and in north-east Ireland.

The intrusions related to a central complex are of different types, linked together genetically in most cases, and arranged in forms obviously geometrically dependent on a common centre. Two important classes of intrusion have been recognised. They are called ring-dykes and cone-sheets. Although the names are self-explanatory we shall consider briefly the geometry of their forms.

In the first case (ring-dykes) the intrusions are annular or arcuate, and arranged concentrically around a centre. They may consist of both plutonic and hypabyssal rock types. Normally the ring-dykes are plutonic and the cone-sheets hypabyssal. Ring-dykes vary considerably in size, from 100 yards to a mile in width, and the geologists who know them best believe that they are inclined steeply outward from the centre.

The cone-sheets on the other hand, are inclined inwards at about 45° towards a common focus. Individual cone-sheets are thinner than ring-dykes. Cone-sheets, however, occur in great abundance and a coastal section may actually show more of the igneous rock than of the country rock. Narrow wall-like strips of country rock between either ring-dykes or cone-sheets are called screens.

We are here specially concerned with ring-dykes and cone- sheets, but no account of the Scoutish Tertiary igneous rocks woiild be complete which did not mention the north-west dykes. These cut the basalt lavas, the plutonic complexes, and the oldfer rocks and are arranged in an orderly manner into swarms passing through the igneous complexes. Thus there are dyke swarms cennected with the centres of Skye, Mull, and Arran etc., and others apparently related to centres not now visible. On the geological map of Britain these dyke swarms make a prominant feature. Individual dykes run for many miles, a dyke from the Mull swarm, for example, may reach the North Sea in the north of England. The Cretaceous dykes of the Bosphorus constitute a swarm.

For the benefit of my Turkish friends I may be permitted to speak about one of these Tertiary centres. The choice is difficult, but let us take Mull, although it is extreinely complicated.

There are two igneous centres in Mull. The earlier lies in the south-eastern part of the island (Fig. 1 b, No. l) and the later somewhat to the north-west (No.2).

In Mull the first phase or the igneous activity is represented in its earliest period by extensive and thick lava flows. On the mountain of Ben More there are 3000 ft. of olivinebasalt lavas. These were followed by more lavas, free from olivine, which are called lavas of the Central Group. These, also, may attain a thickness of 3000 ft. and in Central Mull they are characterised by the existence of pillow lavas. The latter are interpreted as having been formed in a crater-lake occupying a central caldera of subsidence. The great thickness of the pillow lava assemblage also indicates repeated sinking of the floor of the caldera. This fact is important. So also is the fact that, within the caldera, none of the later vent-agglomerates carry up fragments of the Mesozoic or underlying pre-Cambrian. Outside the caldera, fragments of the floor-rocks are abundant in the agglomerates. This obviously indicates great subsidence within the caldera.

At a later date the area of the caldera became the scene of great intrusive activity and today we find much of the celdera destroyed by major intrusions, vents, ring-dykes, and cone sheets arranged concentrically around the centre. The interpretation of the complex history of Mull will always remain one of the great victories of geology.

Outside the caldera, the country rocks are also concentrically folded into anticlines and synclines, in one place with dips reaching the vertical. This folding was caused by the pressure of the uprising magma mainly in the form of great acid ring dykes.

A glance at Fig. 1 will show that Centre No. 1 is not now complete. The intrusions form a great series of concentric horseshoes, but originaIly they probably went right round the centre. Centre No. 1 ceased its activity and igneous action shifted to the north-west into Centre No. 2.

Centre No. 2 is best marked by a great ring-dyke called the Loch Ba ring-dyke, intruded along a ring-fracture which also acted as a ring-fault. The latter has been shown to bound an area of subsidence of some 3000 feet. The dyke is of felsite and it appears to dip outwards and to fill the space left between a sinking central block and the stationary block outside. Proof of great subsidence is afforded by the fact that the basalt lavas within the ring-fault belong to the Central Group whereas the lavas outside at the same leval are about 3000 feet below the top of the Plateau Group.

Consideretions of space make it impossible to continue the story further or in any greater detail. Enough has been said, I hope, to illustrate the general story. In a later section we shall return to the question of the origin of the above features.

The Tranaversals of Turkey.

Turkish geologists are already familiar with the transversals of their own country. They have been fully and clearly described by Professor Parejas in a valuable memoir of the Science Faculty of Istanbu University. It is unnecessary for me to do more than enumerate them here for the benefit of my friends abroad. On the accompanying small-scale map (Fig. 3) the following seven Turkish transversals are indicated. From west to eastthey are:

1. Dardanelles-Menderes massif.
2. Sea of Marmara-Antalya,
3. İstanbul-Beyşehir-Anamur.
4. Tuz Gölü (passing near to Konya)
5. Kızıl Irmak.
6. Malatya-Sivas-Samsun.
7. Caucasus-Van-Cizre.

A wealth of detail, stratigraphical and structural, relating to these is hiven by Parejas in the memoir mentioned above, Nothing more need be added here, for having accepted the truth of Paréjas thesis, we are chiefly concerned with the directions of the transversals.

Paréjas, however, did not confine his attention to Turkey, for he indicated the continuations of certain of the Turkish transversals across the Black Sea into Bessarabia(4),the Crimea(5), the Sea of Azof (6) and in the case of the transversal of Van (7) he followed it far to the north across the Caucasus into the region of Stalingrad. Further east, two more transversals were shown: (a) between the rivers Volga and Ural and southward along most of the Caspian Sea and (b) from the Aral Sea. To the south of Turkey the Antalya transversal (2) crosses the eastern Mediterranean to Palestine, and the Istanbul transversal (3) croeses Cyprus and continues into the Lebanon.

The Transversals of Iran

Since the publication of the memoir on Turkish transversals by Parejas, a description of those of the neighbouring country of Iran has been given by J. W. Schroeder. According to this author ten transvarsals are provisionally recognised. Below, we shall indicate their courses in a little more detail than we have done with their Turkish counterparts. The transversals of Iran are as follows (Fig. 4):

1) *Mosul — Urmia — Caspian.*

This depression passes through Lake Urmia, Tabris, the north-western termination of the Elbourz Mountains, and so on to the Caspian Sea. It corresponds to the South-western continuation of the Caspian transversal of Parejas. The most notewor- thy feature of its direction is the south-westerly course which it follows in Iran.

2) The transversal of South Kurdistan and the Pusht-i-Kuh. This is recognised within the Arabian platform in the Jebel Mamrin anticline. It continues through Afshar and Khamsen to the west of Zenjan and on to the high mountains of Pusht-i-Kuh on the south-western shore of the Caspian at Pahlevi.

3) The transversal of Khaniqin — Resht.

This depression continues from the contact of the Kurdistan and Louristan virgations through the marine Neogene basin of Bijar and the salt-gypsum basin of Mendjil. It reaches the Caspian along the course of the lower Sefid Rud which forms a great deIta into the Caspian.

4) Louristan — Elvend — Elbourz.

This transversal forms the exis of the Louristan virgation in the south-west and passes through the granite mountain of Elvend in the Iranides. It continues to the north-east across the Elbourz Mountains.

5) Dizful — Darya-y - Namak — Firuzkuh.

The course of this Trans-Iran depression is clear. Beginning at the southern end of the Louristan virgation it passes throungh the inland drainage area of Sultanabad, the depression of Darya- Namak, and the thick Miocene and salt-gypsum deposits of Ghom. Within the Elbourz Mountains the Tertiary basin of Firuzkuh lies along the line of the transversal.

6) Kuh-i-Zardeh—Kashan—Semnan.

This elevated transversal runs from the mountains of Zardeh Kuh in the Kuzistan virgation, across the high plateau to Kashan and on to Semnan where it is shown as ending. It probably continues across the Elbourz.

6a) The depression of Dasht-i-Kevir.

6b) Karun-Anarek.

This begins at Marmatan, passes through the mountains of Karun, the Palaeozoic of Du-Palan, the granite of Anarak mountain, and then on to Hauz-i-Panj, Chah Nigu, and Jandaq south of the great depression of Dasht-i-Kevir.

7) The depression of Aghda, and the eastern end of Dasht- i-Kevir.

8) Shir—Kuh.

From the mountains of Kuh-i-Barm and Kuh Bul of the Iranides in the south-west this transversal runs through Shir-Kuh, Pusht-i-Badam, Robat-i-Khan and on through Korassan to Gouchan in the north-eastern mountains.

9) The depression of Kuhistan contains the depression of Bafq and the Kevir of Bijistan. If it is continued to the south- west it probably meets the Parsian Gulf at Bushire, but this part of the course is not shown on the accompanying map,

9a) The transuersal of Laristan.

This begins to the south-west as the axis of the Fars-Laristan virgation of the Border Folds, continues through the Niriz Mountains, the Palaeozoics of Kuhbenan and Kuh-i-Naibabdan in central Iran and so on to the north-east across the Kuh-i-Kalat. This transversal is interesting for it appears to separate a Mediterranean facies from an Indo-Malayan facies.

9b) The depression of Qishm-Saidabed.

This depression is not shown on Schroeder's map but in the text it is described as aligned along the axial depression of the Border FoIds utilised by the Rud-i-Shur, through the region of Tarum into the Kevir of Sirjan

10) The transversal of Kuh-i-Furgun.

On this (secondary) transversal lies the mountain of Furgun, so far the only known locality m Iran with Silurian.

Although Schroeder's evidence for the existence of the above Iranian-transversals is nothing like so complete as wemightwish, yet it seems probable that they do exist with approximately the courses shown on the map. Lack of further information makes us accept them in the meantime. There is no doubt about the existence of some of them as drawn by Schroeder, and the others follow roughly parallel courses.

The Origin of Ring - Fractures and Its Possible Bearing on the Origin of Turkish and Iranian Transversals.

(a) Ring-Fractures

Let us turn now to the mode of ring-fractures of the types described in the first part of this article. Dr. E. M. Anderson is a very mathematically - minded geologist who worked in the field in Mull and who has furnished us with the mechanical explanation of the fractures. The following summary is based entirely on Anderson's writings. (Fig. 5)

First of all we must picture the Tertiary terrain as consisting of a more or less horizontalsurface atthe time of fracturingand of the intrusion of the ring-dykes and cone-sheets. Below this surface there was a magma reservoir at a depth of several miles and under a pressure sufficient to raise it to the surface once it was given an outlet. It is interesting to point out here that by projecting cone-sheets downwards with their observed angles of dip the approximate depth of the magma basin to which they are related is found to be about three miles below the surface. This may be an underestimate for the dips may increase with depth.

Under the initial conditions of equilibrium no fractures would originate. If, however, conditions were changed and the magma basin was subjected to an increase of pressure then a system of tensions would develop across surfaces which, near the basin would be roughly conical. The fine lines in Fig. 5 b show the traces of these surfaces. At the same time another system of pressureswould act across surfaces cutting the former orthogonally. These are shown by broken lines. Accordingf to Anderson's calculations the tensions together with the increascd pressure of the magma would cause a series of fractures to develop and these would follow the thin firm lines on the diagram. With the intrusion of magma along these fractures cone-sheets would be formed. The attitude of these fractures on the flanks and at the basin, more gently inclined in the former and steeper in the latter, agree with field observations on cone-sheets.

If the conditions were reversed and the pressure of the magma fell below that which was assumed at first, the original hydrostatic pressure in the crust would be modified in a different way. Superimposed pressures would act across the surfaces whose trace is shown by the fine firm lines. Superimposed tensions across those which are indicated by the broken lines. It seems likely that in this case surfaces of fracture would originate inclined at an angle to the surfaces across which there were maximum supenmposed tensions, as in the case of normal faults. This angle may have been about 20º to 30°. Such surfaces of fracture correspond not to tension-cracks, but in theory at least more nearly to planes of maximum shearine stress. They deviate from the directions across which this stress is an absolute maximum, owing to certain considerations of friction.

An attempt to show the trace of such surfaces is made in the diagram. It can easily be seen that theory explains the tendency to an outward slope, which as we have said already is a feature of ring-dykes.

If the fractures formed curves that were closed in cross-sections the rock inside them might ter d to become detached and to sink downward into the magma. The gap between the subsiding mass and the stationary walls would widen with subsidence and this perhaps explains the greater width of ring-dyked compared with cone-sheets.

In many cases these fractures may rot have reached the actual surface of the ground, but in two important cases at least in Scotland we know that they did. One of these is in the great caldera of Mull which we have said shows evidence of repeated subsidences. The other is an Old Red Sandstone centre of igneous activity which we have not mentioned but which is equally famous, namely the Cauldron-Subsidence of Glencoe. Here a cylindrical mass of lavas resting on crystalline schists has subsided for thousands of feet into the schists. At the time of subsidence great granitic ring-dykes weie formed along the circular fractures. Another Old Red Sandstone cauldron-subsidence forms Ben Nevis, the highest mountain in Scotland.

(b) Turkish and Iranian Transversals

Paréjas was not concerned with the ultimate origin of the Turkish transversals. His task was to demonstrate their existance and where possible to date their beginnings from stratigraphical evidence. All this he has done convincingly. Paréjas has pointed out, however, that there is apparently a relationship between seismic activity and the transversals. This relationship is not strikingly apparent on the most recent earthquake map of Turkey by Egeran and Lahn except perhaps in the cases of (a) the Konya seismic belt which lies to the west of the axis of the Tuz Gölü (4) depressed transversal,

(b) the Uşak-Isparta seismic belt, parallel to the Antalya (2) transversal and (c) the Izmir-Agaean belt bordering the Agaean Sea. A conspicuous seismic belt coincides with the fracture belt of Maraş-Antakya. The main earthquake zones are parallel to the longitudinaltrends of the Alpine foldings.

Paréjas goes further and sees a parallelism between the Turkish transversals (except in the case of that of Van) and the major dislocations of the Mediterranean region as drawn by Sieberg from the Red Sea to the North Atlantic. Here we might remark in parenthesis on the parallelism of these and the Tertiary north-west dykes of Scotland to which we have already referred. When, however, the Turkish transversals are considered together with those of Iran the above parallelism appears to be somewhat accidental. Few will deny that the Turkish and Iranian transversals must be considered together (fig. 6) and the explanation of the origin of the one set must be applicable to the other.

Schroeder has attempted to explain the origin of the Iranian transversals by pointing to the three main elements of the Arabian-block to the south and west. These elements are:- (a) the massif of Nejd in the central region, (b) the Palestinian depression in the west, and (c) the Rub-al-Khali depression in the south-east. The two main transversals, numbers 5 and 6b above, he says, owe their origins to the resistance of the central massif to move- ment in this part of Iran towards the south-west and so the folds tended to rise. The others are on the whole due to ease of movement. This explanation seems so inadequate that we are still left to wonder why the various transversals have followed their particular courses. As we can see from the map (Fig. 6) they are symetrically arranged around the northern end of the Arabiar block.

First let us review briefly what we know about the tectonics of the region. The existence of the fold mountains of Turkey and Iran is common knowledge. So is the existence of the Arabian block. Whether or not the latter played an active or a passive role in the folding of the mountains is not important. We can chose between a southward-moving series of folds and a stationary block, or a northward-moving block causing the mountains to fall over it. Movement is relative. The second assumption is the more orthodox, so suppose we consider the southern block as pushing northward.

We also know that the formation of the fold mountains of Turkey and Iran was not completed by one continuous push. Studies of the unconformities indicate that movement occurred at various times separated by periods of comparative rest. The long histories of the transversals, too, has been followed in detail by Paréjas. The effects of the pressure and release of pressure are represented today by longitudinal foldings (including overthrus tings) transversals and uncomformities. The geological map shows these features in horizontal plan.

The diagram, Fig. 5b, illustrating the theoretical mode of formation of ring-fracture shows us the effect of somewhat similar pressure effects in vertical section. Here the section is through the inaccessible part of the crust-a magma reservoir and its cover. The existence of the magma reservoir is a geological reality. The effects of the movements of this magma have been determined mathematically and they agree with the observed horizontal section available to the geologist.

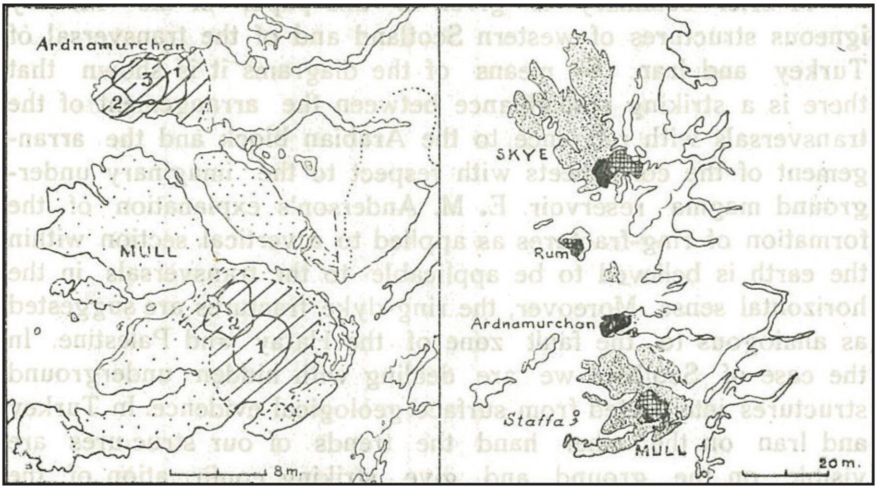
In neither of these two cases can we imagine that absolutely ideal conditions existed. The ring-fractures are seldom true circles. Irregularities in the make up of the strata over the reservoir, in the shape of the reservoir itself, and other factors must be expected to influence the final arrangement of the folds and fractures. In the same way the shape of the northern margin of the Arabian block is only imperfectly known in the land area of southern Turkey, northern Syria and Iran. In the eastern Mediterranean it lies beneath the sea. The rocks of the folded regions, too, vary in composition and in constitution and, therefore, in their reactions to pressure and release of pressure. For these reasons we must expect irregularities in the arrangements of the fold mountains and transversals. Such irregularities are obvious features of the map.

In spite of what we have just said, however, no one can deny (a) that the mechanical effects of the movement of the underground magma in the case illustrated in Fig. 5 and of the movement of the Arabian block (Fig. 6) will produce somewhat similar results. The one acts vertically and the other more or less horizontally. Or (b) that there is a striking resemblance between Fig. 5 and Fig. 6. If this is admitted, then the transversals owe their origin to pressure effects analogous to those which produced cone-sheets.

We may be permitted to go further and suggest that the ring-dyke type of fracture can also be found in southern Turkey and northern Syria (Fig. 7). It is represented on the western flank of the Arabian block by the great fault and earthquake zone which runs from Maraş to Antakya within the "cover" of the block and which continues southward into and through the block itself as the fault zone of the Lebanon, Palestine-Transjordan, and the Gulf of Aqaba. There is little that we can point to on the eastern side of the block for comparison with these fractures.

Summary and Conclusion

A brief summary is given in this paper of the Tertiary igneous structures of western Scotland and of the transversal of Turkey and Iran. By means of the diagrams it is shown that there is a striking resemblance between the arrangement of the transversals with reference to the Arabian block and the arrangement of the cone-sheets with respect to the imaginary underground magma reservoir. E. M. Anderson's explanation of the formation of ring-fractures as applied to a vertical section within the earth is believed to be applicable to the transversals in the horizontal sense. Moreover, the ring-dyke fractures are suggested as analogous to the fault zone of the Hatay and Palestine. In the case of Scotland we are dealing with hidden underground structures interpreted from surface geological evidence. In Turkey and Iran on the other hand the trends of our structures are visible on the ground and give striking confirmation of the trends deduced by Anderson for his unseen underground fractures.



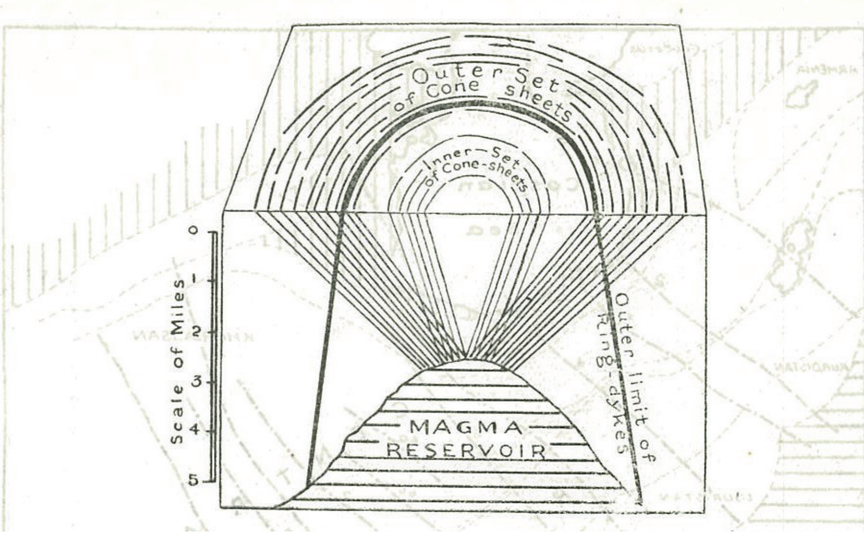
a b

(Şekil 1) a. Batı İskoçya'daki bazı erüptiv faaliyetlerin merkezlerini gösterir harta. Noktalı kısımlar lâvları; siyahlar bazik plütonik entrüzyonları; kare çizgiler de asitik plütonik entrüzyonları gösterir.

b. Mull ve Ardnamurchan'ın şematik hartası - Entrüziv kompleksler mail çizgilerle; erüptiv faaliyet merkezleri numaralarla; lâvlar noktalar ile gösterilmiştir. (Her iki şekil de Richey'den modifiye edilmiştir).

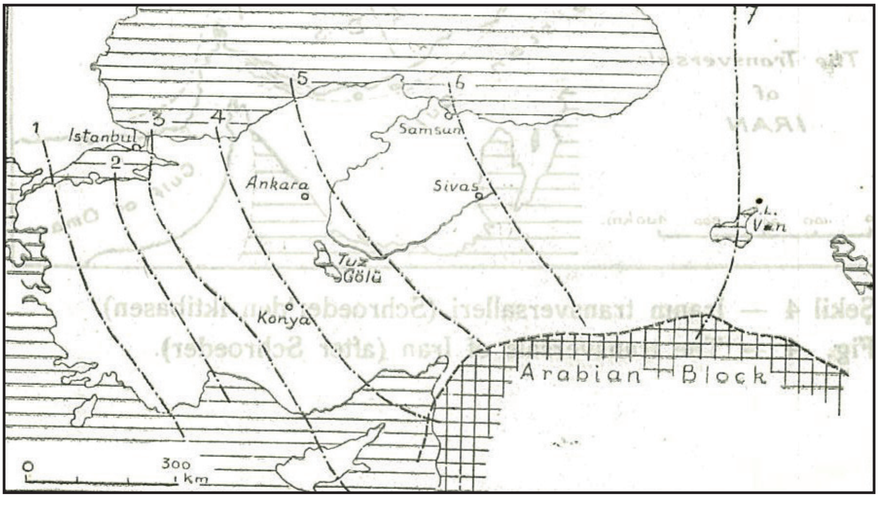
(Fig. 1) a. Locality map showing some of the centres of igneous activity in western Scotland. Dotted areas lavas; black, basic plutonic intrusions; cross-hatched, acid plutonic intrusions.

b. Sketch - map of Mull and Ardnamurchan. The intrusive, complexes are lined. Centres of igneous activity are numbered. Lavas are dotted. (Both diagrams modified after Richey)



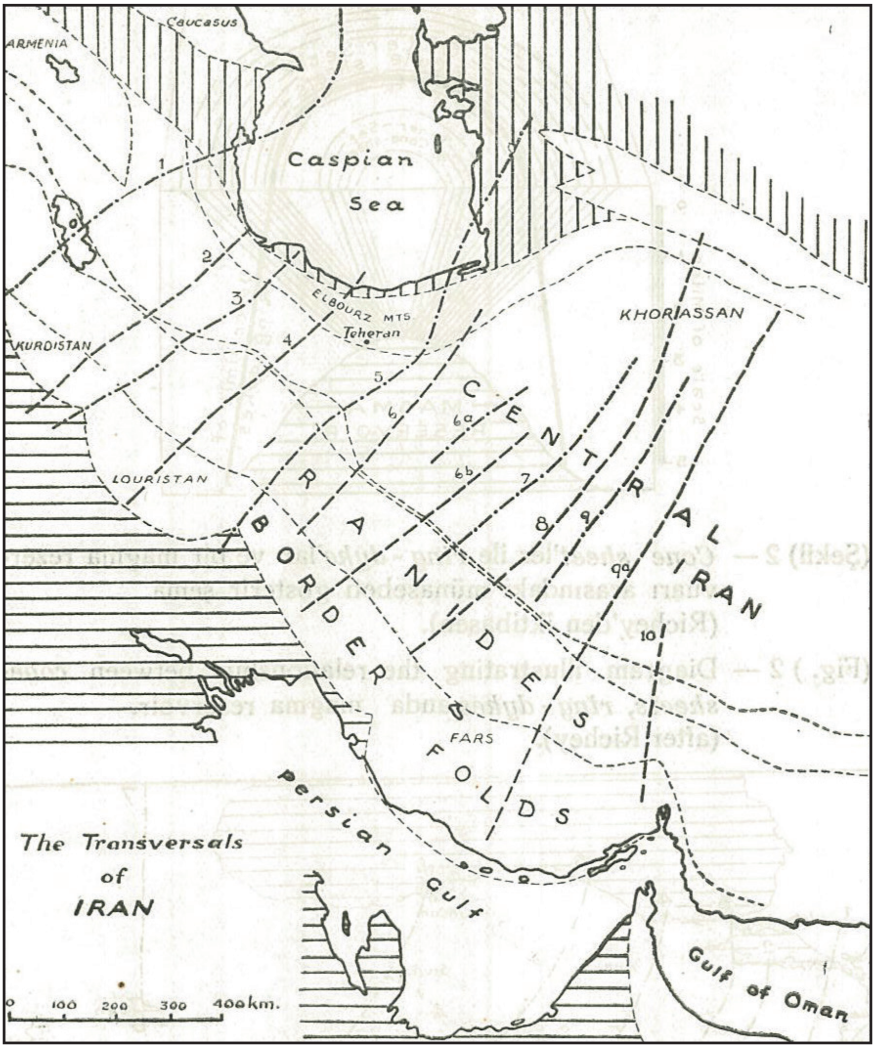
(Şekil) 2 — Cone - sheefler ile ring - dyke'lar ve bir magma rezervuarı arasındaki münasebeti gösterir şema. (Richey'den iktibasen).

(Fig.) 2 — Diagram illustrating the relationship between cone-sheets, ring-dykes, anda magma reservoir. (after Richey).



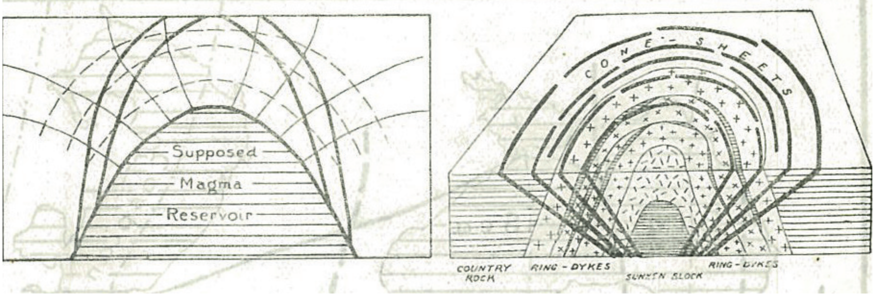
(Şekil 3) — Paréjas'a göre Türkiyenin transversalleri.

(Fig. 3) — The transversals of Turkey according to Paréjas.



Şekil 4 — İranın transversalleri (Schroeder'den iktibasen).

Fig. 4 — The transversals of Iran (after Schroeder).

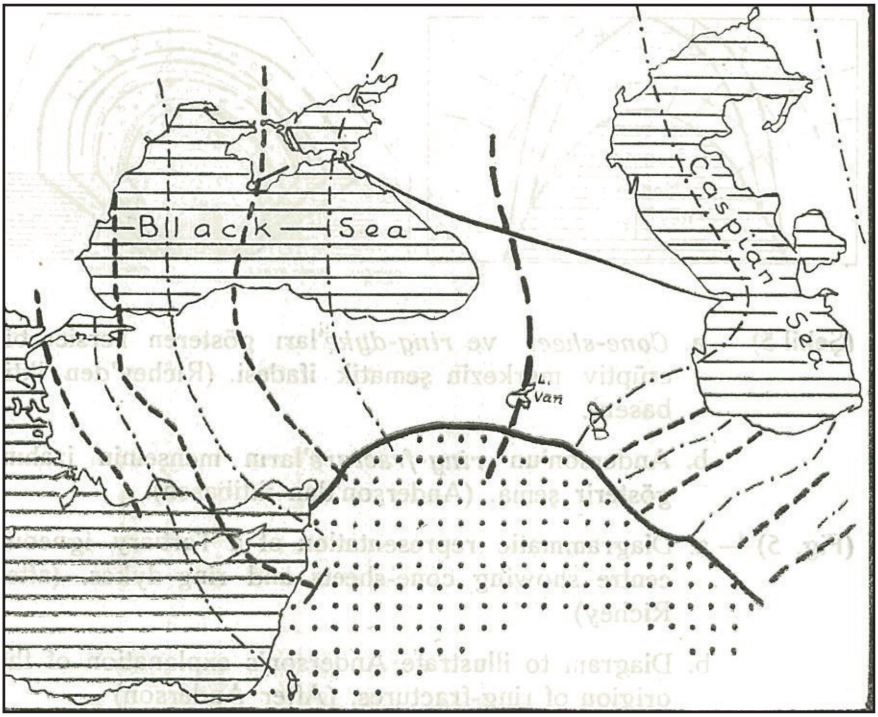


(Şekil 5) - a. Cone-sheet ve ring-dyke'ları gösteren Tersier bir erüptiv merkezin şematik ifadesi. (Richey'den iktibasen).

b. Anderson'un ring-fracture'ların menşeinin izahını gösterir şema. (Anderson'dan iktibasen).

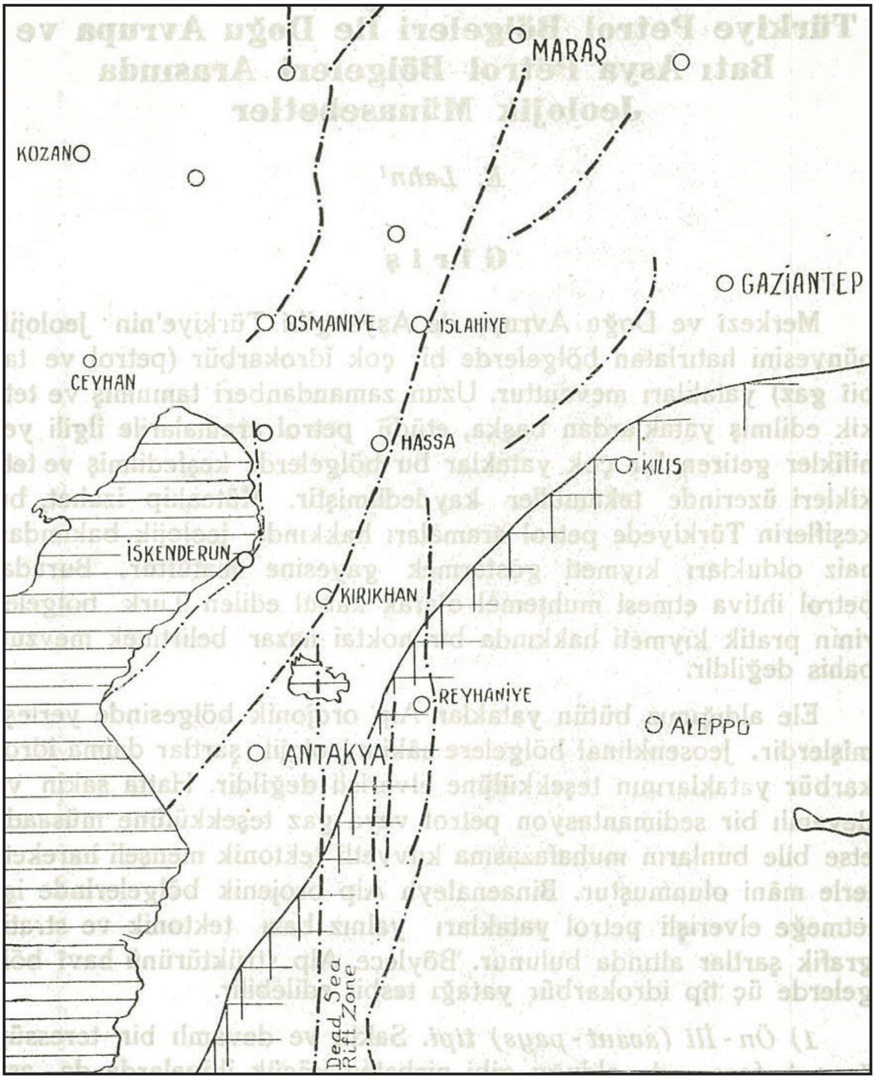
(Fig. 5) - a. Diagrammatic representation of a Tertiary igneous centre showing cone-sheets and ring-dykes. (after Richey)

b. Diagram to illustrate Anderson's explanation of the origion of ring-fractures. (After Anderson)



Şekil 6 - Türkiye ve İran tranversallerinin Arap Blokuna olan münasebetleri

Fig. 6 - The transvesals of Turkey and Iran showing theirrelationship to the arabian platform.



(Şekil 7) - Güney Türkiye ve Kuzey Suriyenin başlıca fraktürleri ile bunların Arap Blokunun Kuzey sınırına olan münasebeti (Malatya Tektonik Hartası. M. T. A. Enstitüsü, Ankara).

(Fig. 7) - The main fractures of southern Turkey and northern Syria showing their relationship to the northern border of the Arabian platform (after Malatya Tektonik Hartası, M. T. A. Enstitüsü, Ankara).