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## **On the geochronology by K-Ar method of the Rize pluton in the region of Güneyce-Ikizdere, Eastern Pontids, Turkey**

by *Mehmet Fevzi Taner\**, *Michel Delaloye\*\** and *Marc Vuagnat\*\**

### **Abstract**

The Rize Pluton is situated in the Eastern Pontids. The Güneyce-Ikizdere area consist mainly of plutonic rocks of calc-alkaline composition and of Cretaceous volcanic and volcanoclastic formations.

Potassium-argon age determinations were carried out on mineral concentrates as well as on whole rocks. An isochrone is calculated for samples from Maki Deresi-Ikizdere area (71 m.y.) and a second one for samples from Cimilbasköy (42 m.y.). The obtained results lead to the conclusion that the emplacement history is quite complex and lasted a long period. The intrusion of the Rize pluton was synorogenic and took place in the main phase during the Laramide tectonic orogeny.

### **Özet**

Rize plütünü genellikle kalko-alkalin bileşimde çeşitli granitik fasiyeslerden oluşan ayrışık (heterojen) bir yapı göstermektedir. Plütünü kenarından merkezine doğru bir zonlaşma izlenir. Kenar kısmı tonalitik özellikli yer granofirik fasiyes içeren ve bilhassa ince taneli doku gösteren kayalardan oluşur. Merkeze doğru, genellikle iri tane dokulu, bol K-feldspat içeren granodioritler bulunur. Yer yer iri K-feldspat kristallerinin bulunması granodioritlere porfiroid bir özellik verir. Plütünü yakınında bulunan Kretase yaşlı volkano-sedimanter oluşumlar kontak metamorfizmaya uğramışlardır.

Elde ettiğimiz yaş grupları, ayrışık yapıya sahip olan Rize plütünü yerleşme evriminin karmaşık olduğunu göstermektedir. Plütünü yerleşmesi genellikle Alp orojenezinin tektonik evrelerine göre gelişmiştir. Yaşlar, Güneyce bölgesinde 215 ve 131–153 milyon sene vermesine karşılık, plütünü büyük bir kısmında elde edilen yaş 70 milyon sene; Cimilbasköy cevherleşme bölgesinde elde edilen yaş ise 40 milyon senedir. Jeokronolojik veriler Rize plütünü senorojenik bir entruzyon ve yerleşmenin ana evresinin üst Kretase olduğu varsayımını doğrulamaktadır.

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## 1. INTRODUCTION AND GEOLOGICAL SETTING

The area of Güneyce-Ikizdere (fig. 1) is situated in the Eastern Pontids, one of the four main tectonic units of Turkey outlined by KETIN (1966). The area studied consists mainly of plutonic rocks of calc-alkaline composition and of Cretaceous volcanic and volcanoclastic formations. We are concerned here mainly with the dating of the granitic rocks of the northern part of the Rize pluton.

The Eastern Pontids are made up of a crystalline basement intruded by Variscan calc-alkaline granites. The latter are located near Gümüşhane (ÇOĞULU, 1970). Several marine sequences are found interbedded with the volcanics.

The complicated sequences of Upper-Cretaceous age represent an important feature of the Pontids. They consist of basaltic and andesitic lavas with intercalated pyroclastics and sediments (TANER, 1976; TANER and al., 1978). In the Güneyce-Ikizdere area, they have undergone thermal metamorphism, induced by the intrusion of the plutonic rocks, which at its maximum reaches the horn-

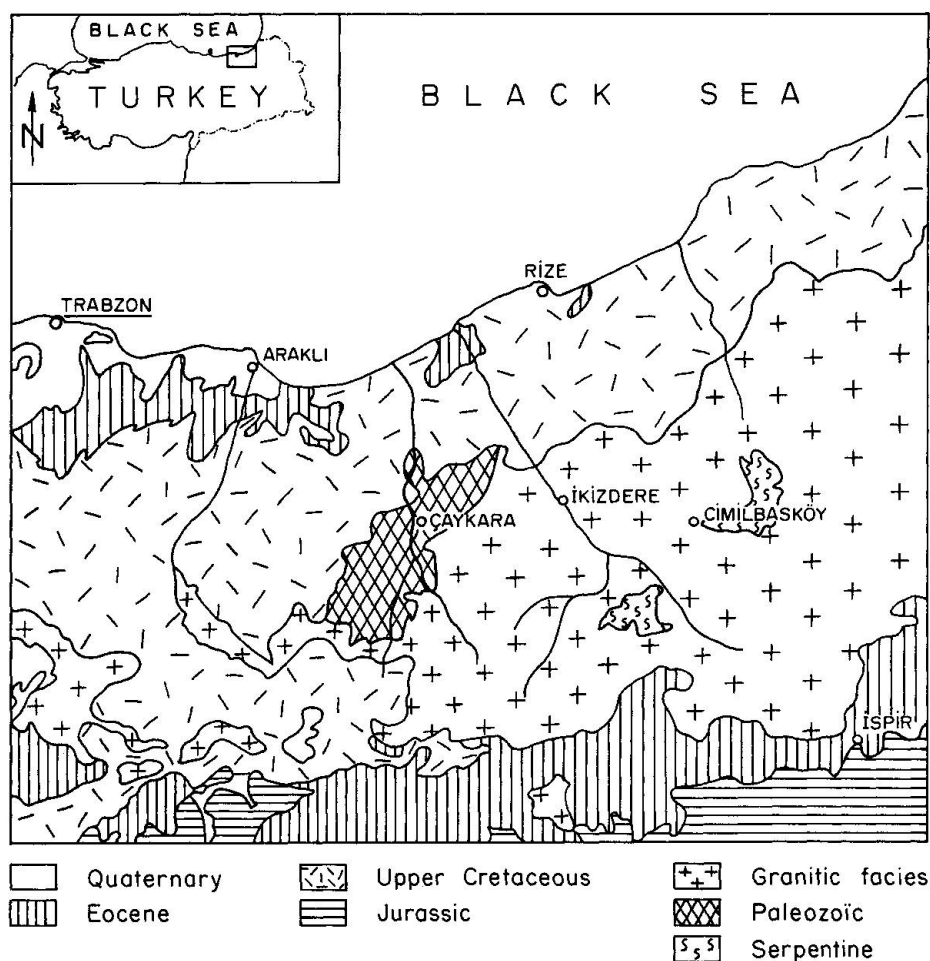


Fig. 1: Geographical and geological setting

blende-hornfels facies. Locally, at the contact between the granites and the Cretaceous limestones, particular minerals (e.g. spurrite and tilleyite) belonging to the spurrite-merwinite facies of REVERDATTO (1973) are developed.

During Eocene times, changes in magmatic character occurred and andesites began to predominate (GATTINGER, 1962; PECCERILLO and TAYLOR, 1976; TOKEL, 1977). Sedimentary intercalations are still abundant in the sequence.

Upper-Tertiary volcanic formations of post-orogenic potassic character are well developed along the Black Sea near Trabzon.

In the area of the Black Sea and the Little Caucasus, it has been shown by PEJATOVIC (1971) that the magmatic activity can be linked to the tectonic phases of the alpine orogeny and in particular to the period between the Kimmerian and the Pyrenean phases. His subdivision of the tectonic history of the Pontids based on magmatic activity is similar to that of ZANKL (1961). The same phases have been found by BERGOUGNAN (1975) in his stratigraphic study of the Pontides.

## 2. THE RIZE PLUTON

The acidic plutonic rocks studied in this paper belong to the so called «Pluton of Rize». It has an ellipsoid shape with its main axis oriented SW-NE. It is about 125 km long and 50 km wide. The highest mountains of the Black Sea Area are located in the pluton (Verçinin Tepe, 3711 m.a.s.l.).

The pluton intrudes Upper-Cretaceous volcanoclastic rocks to the north and west and Eocene sediments to the south. The presence of thermal contact zones in the country rock clearly indicate a magmatic origin for the pluton.

A study by ÇOĞULU (1970) of the contact-metamorphism and geochronology of the Rize pluton has shown that it is alpine in age. It has a typical post-tectonic character and it must have been emplaced between Upper-Lutetian and Oligocene times. Çoğulu divided the rocks into two groups: the first, with large outcrops near Ispir, consisting of syenogabbros to monzonites and the second which are dated in this study developed in the northern part of the massif, and made up mainly of granodiorites to quartz-monzonites. He demonstrated also that the intrusion of the pluton was complex, probably took place in two phases and that differentiation had induced variations in the composition of the rocks these of the southern part being slightly more basic than those of the northern part.

The granodioritic to quartz-dioritic rocks in the Güneyce-Ikizdere area, which belong to the second group of intrusions in the Rize pluton may be further divided petrographically into three units on the basis of the STRECKEISEN (1967) classification of igneous rocks (TANER, 1977).

- a) the Güneyce Unit
- b) the Maki deresi and Mesoraş köyü Unit
- c) the Ikizdere Unit

#### **a) The Güneyce Unit**

This petrographic unit is characterized by a strong development of tonalites showing a granular texture when fresh and a micropegmatitic texture when transformed by alteration. The plagioclase varies from An 5 to An 45. Small amounts of ferromagnesian alteration minerals are also present. An important tectonic contact, with cataclastic fabrics both in the pluton and in the country rock can be seen to the north of Güneyce. Because of this contact, metamorphism phenomena are not apparent in the Turonian sediments.

#### **b) The Maki deresi and Mesoraş köyü Unit**

The intrusions in this unit are mainly granodiorites consisting of quartz, oligoclase to andesine plagioclase, K-feldspar, hornblende, biotite, zircon, sphene, apatite and ore-minerals. At the contact with Cretaceous limestones, high-temperature Ca-silicates such as spurrite and tilleyite are developed.

#### **c) The İkizdere Unit**

This unit has a concentric petrological zonation elongated in a N-S direction. To the north, outcrops of granophyre are found near the contact zone. The middle zone consist of tonalites similar to those of Güneyce, while the core of the massif, south of İkizdere is made up of granodiorites. The domed structure of the country rocks around the unit is almost certainly caused by its intrusion. The dykes cutting the unit are doleritic with a porphyritic texture and chilled margins, and similar to those present in Cretaceous sediments; they are certainly younger than the granitic rocks.

The plutonic rocks of the İkizdere Unit are overlain by volcanics (Rhyolites, obsidians and dacites) near Çagrakaya yaylası. A potassium-argon age determination on an obsidian from this group gives an age of 2 m.y. confirming that these rocks belong to the latest volcanic activity of this area.

### **3. GEOCHRONOLOGY**

#### **a) Introduction and general outline**

Age determinations were carried out at the Department of Mineralogy, University of Geneva, Switzerland on an AEI-MS-10S mass spectrometer. The  $^{38}\text{Ar}$  spike is from Schumacher or from Clusius with a purity of 99.98%. Decay constants are those recommended by the Sub-commission on Geochronology, Sydney 1976. Potassium concentrations were measured by flame photometry.

Absolute age determinations made in the region studied are relatively numerous and it is useful to review them here.

The Gümüşhane crystalline massif situated 100 km to the SW has given Hercynian ages from zircons and also mid-Jurassic biotite ages (ÇOĞULU, 1970) while YILMAZ (1977) has published some Hercynian ages for the Caykara massif situated about 20 km to the SW of Güneyce. One can see therefore that the Hercynian ages have been rejuvenated. It seems to be the same for the rocks we have dated. The two ages of 210 m.y. (samples no 155 and 323) are probably mixed ages for there is no geological or petrographical evidence – for example the existence of a metamorphism – in these tonalitic rocks pointing to a Triassic age. On the other hand, the ages between 130 to 150 m.y. (samples 31 and 56) seem more significant than those found elsewhere. PEJATOVIC (1971) describes in the little Caucasus some plagiogranite (tonalite) intrusions which have been emplaced between the Upper Jurassic and the Lower Cretaceous. He has also described similar intrusions in the Eastern Pontides the age of which is as yet unknown.

GILES et al. (1973) give biotite ages of 127 and 132 m.y. obtained from granodiorites situated to the north of Ispir.

According to YILMAZ (1977) the Çaykara granite of Hercynian age (257 m.y.) was rejuvenated at about 142 m.y., (dating by Rb-Sr method); this corresponds to the Kimmerian tectonic phase.

It should be pointed out that in the region where Jurassic ages have been measured, tectonic contacts with the Turonian volcano-sedimentary formations have been observed. There is practically no contact metamorphism.

On the basis of these different observations it is proposed that the plutonic rocks in the Güneyce region have been emplaced before the lower Cretaceous and that they could be contemporaneous with the late Kimmerian tectonic phase, recognised in the Eastern Pontids by PEJATOVIC (1971) and BERGOUGNAN (1975). If the ages of 210 m.y. were confirmed, for example by the Rb-Sr method, this plutonism would have already commenced during the early Kimmerian phase.

Ages measured from the Maki Deresi, İkizdere and Cimilbaşköy regions, are spread between 40 and 80 m.y.

The samples coming from Cimilbaşköy (nb. SD8, KD5, CD5, K12) show signs of being hydrothermally mineralised, they contain chalcopyrite, pyrite and molybdenite of the «porphyry copper» type. This mineralisation has certainly modified the primary composition of the minerals, influencing their age. Ages between 30 and 47 m.y. have been published by DELALOYE et al. (1972) from samples from the south of the region studied. GILES et al. (1973) have measured a biotite age of 41 m.y. from granodiorites in an unusual batholith about 100 km SW of İkizdere. Hence, it is probable that its emplacement has taken place during the Pyrenean tectonic phase.

On the other hand, the isotopic ages of the samples from the Ikizdere – Maki deresi region are between 63 and 80 m.y. (nb 390, 212, 350, 296, 2/74). Thus it is likely that the principal intrusion of the Ikizdere region plutonic rocks took place during the Laramide tectonic phase. Gedikoglu (oral communication) has obtained similar ages for the Harsit granite about 150 km to the West.

TABLE I : Analytical data and K-Ar ages of the Rize pluton

Sample numbers	Provenance area and rock type	Dated material	% K	Ar <sup>40</sup> Radiogenic (10 <sup>-10</sup> mol./gr)	% Ar <sup>40</sup> Radiogenic	Apparent age in m.y.
KA-911 323	Güneyce (Tonalite)	Whole rock	0.18	.627	40.1	190.4 ± 20.9
KA-910 155	Güneyce (Tonalite)	Whole rock	0.12	.464	44.5	210.3 ± 21.0
KA-721 56	Güneyce	a) Whole rock	0.09	.228	47.1	133.5 ± 10.0
KA-824	(Diorite)	b) Amphibole	0.11	.283	43.3	142.7 ± 17.8
KA-909 31	Güneyce (Tonalite)	Whole rock	0.13	.287	44.9	122.8 ± 15.8
KA-724 390	Maki deresi (Granodiorite)	Biotite	5.70	7.953	88.9	78.7 ± 2.9
KA-725 212	Maki deresi Mozom (Granodiorite)	Biotite	4.36	5.576	84.2	72.3 ± 2.7
KA-718 350	Maki deresi Mesoras Köyü (Granodiorite)	Biotite	5.90	6.967	85.5	66.8 ± 2.4
KA-722 296	Ikizdere (Granodiorite)	a) Biotite b) Chloritised biotite	3.11 1.46	4.555 1.717	80.9 71.0	82.5 ± 3.8 66.6 ± 3.3
KA-719A 217A	Yagcilar/Ikizdere (800 m.)	a) Biotite	4.75	6.490	86.9	77.1 ± 2.7
KA-719B	(Granodiorite porphyroide)	b) K-feldspar	8.83	10.778	94.6	69.0 ± 2.3
KA-720 SD8	Cimilbasköy (Granodiorite)	K-feldspar	8.09	6.494	84.4	45.7 ± 1.7
KA-723 KD5	Cimilbasköy (Granodiorite)	K-feldspar	8.75	6.261	75.7	40.8 ± 1.7
KA-1124 CD5	Cimilbasköy (Granodiorite)	Biotite	6.76	4.777	87.5	40.3 ± 1.4
KA-1125 K12	Cimilbasköy (Granodiorite porphyric)	Amphibole	0.632	0.536	73.3	48.3 ± 2.5
KA-764 1/74	Cağrankaya Y./ Ikizdere (Obsidian)	Whole rock	3.95	0.148	51.0	2.1 ± 0.2

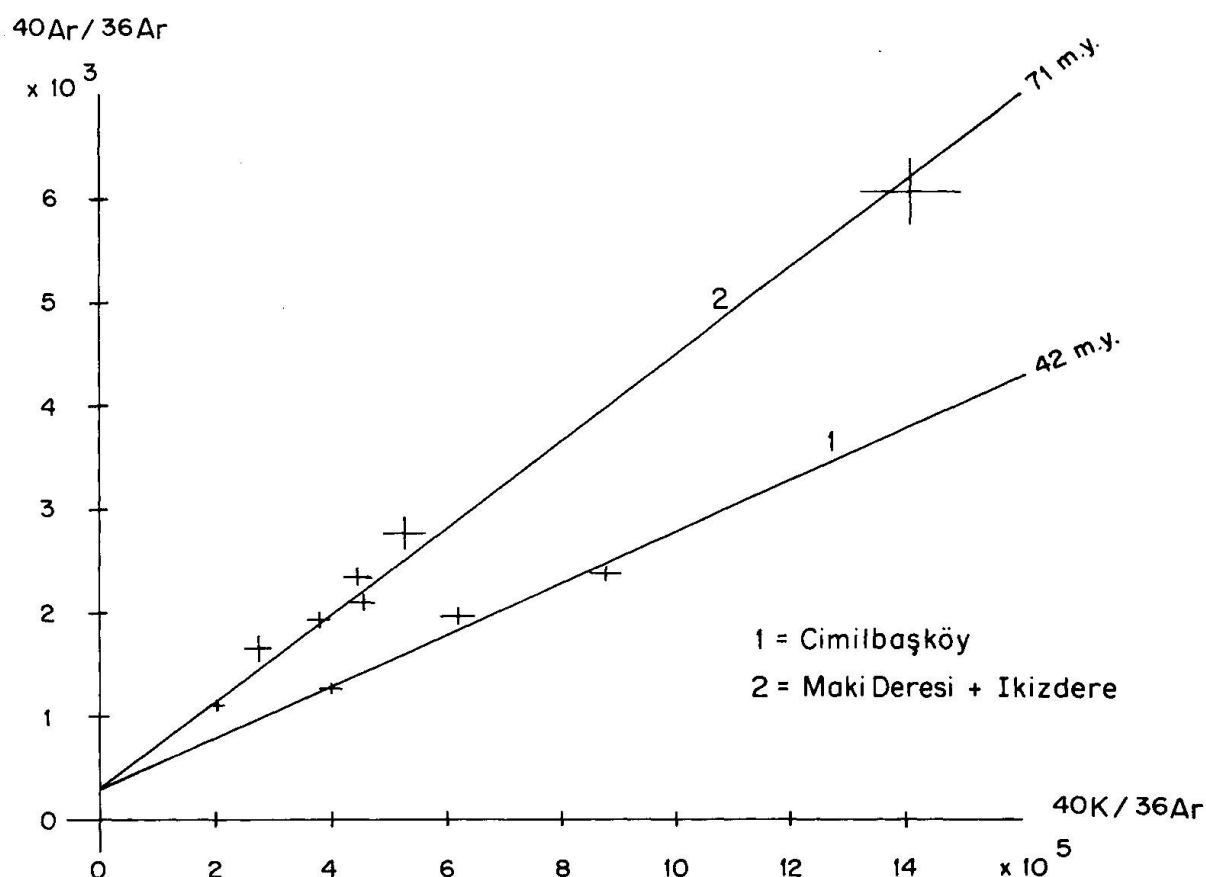


Fig. 2: Isochrone plot of Cimilbaşköy and Maki Deresi - İkizdere samples.

#### b) Isochron analysis

The analytical data from the Maki deresi, İkizdere and Cimilbaşköy samples have been plotted on a  $^{40}\text{Ar}/^{36}\text{Ar}$  v  $^{40}\text{K}/^{36}\text{Ar}$  diagram. Two distinct isochrons are evident, one giving an age of 42 m.y. obtained from the Cimilbaşköy samples only and the other corresponding to an age of 71 m.y. obtained from the rest of the samples. It should be pointed out that the high  $^{40}\text{Ar}/^{36}\text{Ar}$  intercept value for the Cimilbaşköy samples ( $\sim 500$ ) indicates that excess argon was probably introduced during the hydrothermal mineralisation of these samples. The other isochron dates the Laramide phase during which part of the pluton was emplaced.

#### 4. CONCLUSIONS

The emplacement of the calc-alkaline plutonic rocks is complex. The period of intrusion was probably quite long and took place in relation to the main Al-



pine tectonic phase. Because of the use of only a single geochronological method (K-Ar) certain points are still not well known. It is, nevertheless, established that the intrusion of the Rize pluton was synorogenic and took place in the main phase during the Laramide tectonic orogeny.

The geochronological data presented here together with the petrographic and tectonic data published by TANER (1976) do not contradict the plate tectonic interpretation of the eastern Pontids that were an island arc by some authors (e.g. RINGWOOD 1974, DIXON et al. 1974, ATAMAN et al. 1975, TOKEL 1977).

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