THERMOMETRIC ANALYSIS OF SOME SAMPLES FROM POTWAR AREA

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Eleven rock samples were taken from Potwar area for paleotemperature determination. The present study has shown that the maximum temperatures of crystallization of calcite may be approximately equivalent to paleotemperature of the parent rock. The lowest limit of maximum temperature (160°C.) favours the migration of viscous oil and the highest limit of maximum temperature (400°C.) is likely to destroy the hydrocarbons in rocks. Higher temperature has been observed in the older rocks.

Introduction

Temperature of crystallization of secondary authigenic minerals can be used to determine indirectly the paleotemperature of rocks with which these minerals are associated in the form of veins and nests. The temperature of crystallization of minerals corresponds to the temperature of mineralized waters from which they crystallize, which in turn corresponds to the temperature prevailing in the rocks. Paleotemperatures were determined using 11 mineralized rock samples from different parts of the Potwar area.

Temperature of crystallization of minerals can be determined by two methods described below:

Method 1

Disappearance of the Gaseo-Liquid Inclusions.—The crystals which are generated from the solution, retain some parent liquid inclusions in them and in the process of cooling, some portion of the liquid inclusion is converted into gas bubbles due to the creation of vacuum.

If these crystals are heated, the temperature at which the bubbles of gas disappear, gives the temperature of crystallization of the mineral under examination.

But as the experimental data is obtained at atmospheric pressure, which does not take into account the pressures at which the crystals were growing, a pressure correction[1] upto 10°C. at 1000 meters depth is applied to bring accuracy.

Method 2

Cracking of Minerals.—If the gaseo-liquid inclusions are too small to be visible under the microscope, the alternative method is to find out the temperature at which the crystals are cracked.

This can be observed under the microscope by the tremoring produced in crystals as a result of their cracking. This temperature is known as the temperature of explosion which is always 25°-26°C. more than the temperature of crystallization. This is due to the fact that as soon as the temperature of crystallization is approached, the gas bubbles are converted into gases which on expansion create pressure inside the crystal leading to the point of its cracking and as a result tremoring of crystal occurs. The temperature of crystallization can be calculated by the following formula.

Temperature of crystallization = Temperature of explosion-25°C. + 10°C. (Pressure Correction).

Preparation of Mineral Samples for Thermometric Analysis.—As the secondary authigenic minerals (Calcite, Pyrite and Quartz etc.) are in the form of veins or nests in the rock samples, the rock samples are broken in such a way that pure mineral crystals can be obtained. Then these mineral crystals are crushed to pieces and the grains of aleuritic size are separated by sieving. In case the crystals of the mineral are not pure, they are thoroughly washed before crushing them.

Apparatus and its Operation.—The apparatus as shown in Fig. 1, consists of a hand-made small oven nearly 3 inches high and about 2 inches in diameter, having a small hole to hold the thermometer. The mineral grains of aleuritic size (>0.1 and <0.25 mm.) are put in the oven, the upper part of which is covered with a glass strip to eliminate the effect of heat on the optical system of the microscope.

The oven is put under the binoculer microscope through which the grains are examined. The temperature of oven is regulated according to the requirement and is read continuously on the thermometer.

Apparatus Drawback.—Some heat is lost by conduction as the oven is not completely insulated but the fluctuation in temperature is negligible and does not affect the results.

The process is slow as it takes time to cool the oven for the next experiment to be carried out.

Interpretation of Data.—The maximum temperature of crystallization of calcite was determined in 11 samples by the method given earlier and the data obtained is given in Table-1. These samples were from Abylisk (Nicolson) in the north to Kalabagh and Khabbakki in the south-south west as shown in Fig. 2. As shown in Table 1, the

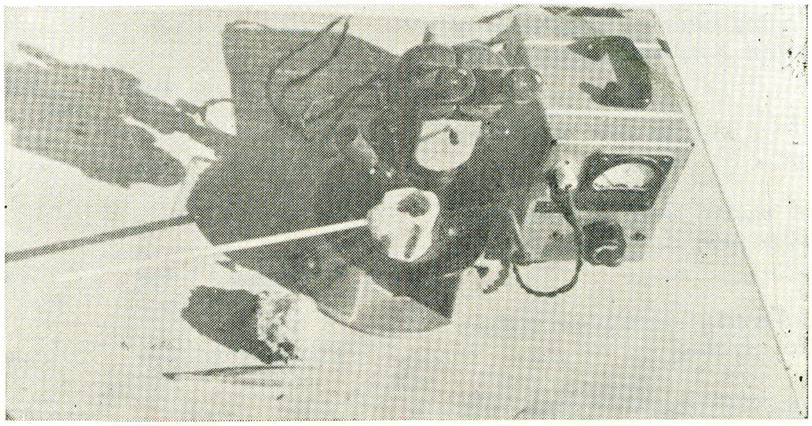


Fig. 1.

TABLE 1.—RESULTS OF THERMOMETRIC TESTS OF SAMPLES FROM POTWAR AREA USING THE METHOD OF CRACKING OF MINERALS.

Test No.	Sample and locality	Age	Approx. distance from Durband (in north) towards south Km.	Temperature of explosion °C.	Temperature of crystallization °C.
(1)	(2)	(3)	(4)	(5)	(6)
1.	Calcite from veins of limestone outcropped near Shah-Allanditta. Sample No. 2L-3·1	Jurassic	55	415(?)	400(?)
2.	Calcite from veins of limestone from Khairi Murrat anticline. Sample No. L-34	Eocene	100	320	305
3.	Calcite from veins of limestone from near Chittidal. Sample No. 2L-16-4 ..	Permian	220	265	250
4.	Rock salt from Warchha salt mine. Sample No. 2L-28-4	Pre-cambrian	225	265	250

Table 1 Continued:—

(*Table 1 Continued*)

(1)	(2)	(3)	(4)	(5)	(6)
5.	Calcite from veins of limestone from Kala-Chitta Range near Abylisk (Nicolson), Sample No. 2L-2-1.	Eocene	60	265	250
6.	Calcite including bitumen from veins of limestone from Khabbakki. Sample No. L-106	,,	195	230	215
7.	Travertina from Murree Hills, near Kala Bagh. Sample No. 2L-34-1. ..	Pre-cambrian	192	208	193
8.	Crystals of calcite from pre-cambrian Murree Hills near Kala Bagh. Sample No. 2L-32-3.	Pre-cambrian	192	205	190
9.	Calcite from Breccia from Patiala Wahan. Sample No. 2L-40-9.	Post eocene	200	200	185
10.	Calcite from veins in Khairabad lime-stone at Nammal. Sample No. 2L-37-28	Paleocene	208	195	180
11.	Calcite from veins in sandstone of Kamlial, Murree formation, Murree Hills near Kala Bagh. Sample No. 2L-33-3. ..	Miocene	192	175	160

TABLE 2.—COMPARISON OF MAXIMUM TEMPERATURES OF CRYSTALLIZATION OF CALCITE IN ROCKS OF EOCENE AGE.

S. No.	Sample and locality	Age	Approx. distance from Durband Batholith towards south. Km.	Tempera-ture of cry-stallization °C.	Remarks
1.	Calcite from veins of limestone from Khairi Murrat anticline Sample No. L-34.	Eocene	100	305	Locality lies in the south of Durband
2.	Calcite from veins of limestone from Kala-Chitta Range, near Abylisk (Nicolson). Sample No. 2L-2-1.	,,	50	250	Locality lies 60 km. in the north east of Khairi Murrat
3.	Calcite including bitumen from veins of limestone from Khabbakki. Sample No. L-106	,,	195	215	Locality lies in the south of Durband
4.	Calcite from breccia from Patiala Wahan. Sample No. 2L-46-9	,,	200	185	,,
5.	Calcite from veins in Khairabad Lime-stone from Nammal. Sample No. 2L-37-28.	,,	208	180	,,

Table 3.—Comparison of Maximum Temperature of Crystallization of the Sample from the same Localities but from Rocks of Different Ages.

S. No.		Sample	Locality	Age	Temperature of crystallization °C.
1.	(a)	Calcite veins in sandstone from Kamlial Murree formation of Murree Hills. Sample No. 2L-33-3.	Kalabagh	Miocene	160
	(b)	Pure crystals of calcite from Murree Hills. Sample No. 2L-32-3.	,,	Pre-cambrian	190
	(c)	Travertina from Murree Hills. Sample No. 2L-34-1.	,,	,,	193

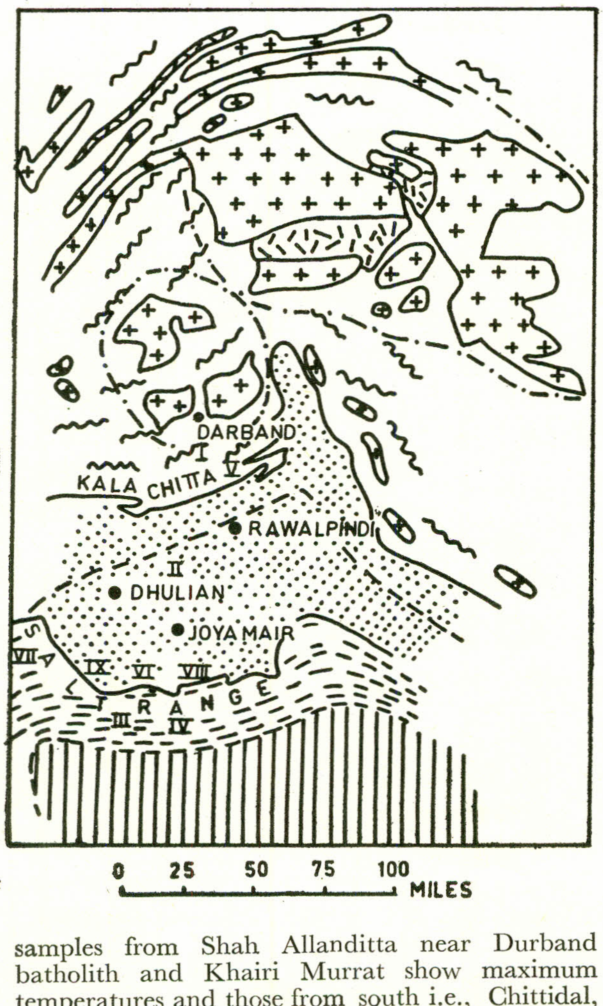
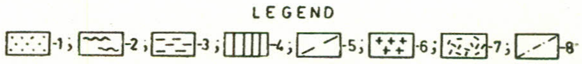


Fig. 2.—Showing exposure of mesozoic intrusive roks towards north from the Potwar trough (Bogdonovich, 1961).



1, Tertiary deposits; 2, Metamorphosed strongly dislocated geosynclinal deposits of mesozoic, paleozoic (prodominent) and pre-cambrian age; 3, Non-metamorphosed platform deposits of mesozoic, paleozoic and pre-cambrian age; 4, Meta-morphosed pre-cambrian deposits; included into consolidated Gondwana platform; 5, Supposed Northern border of Gondwana land; 6, Acid intrusive of mesozoic or even paleocene age; 7, Basic and ultrabasic intrusives of mesozoic age; 8, Contours of supposed megabatolites).

Localities from which the samples have been taken:
(I). Shah Allandita, (II). Kharimurat, (III). Chittadil. (IV). Warcha, (V). Abylisk (Necolson), (IV) Khabbakhi, (VII). Kalabagh, (VIII). Patiala Wahn, (IX) Nammal.

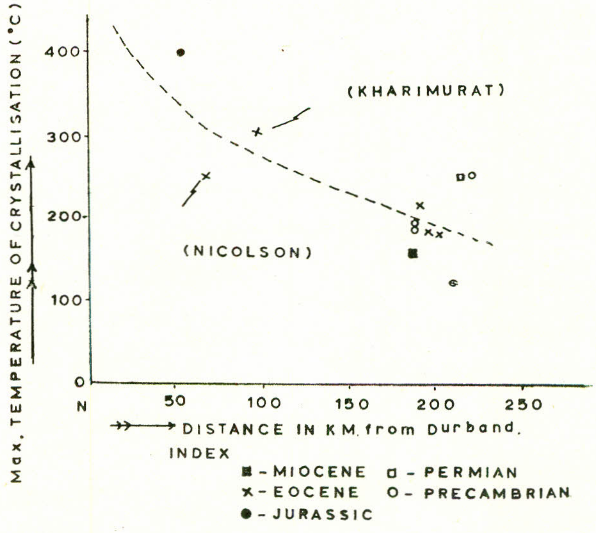


Fig. 3.

samples from Shah Allanditta near Durband batholith and Khairi Murrat show maximum temperatures and those from south i.e., Chittidal, Nammal and Kalabagh, minimum temperatures indicating thereby a prevalance of lower temperatures in south western Potwar and high temperatures in the north. From these data it can be concluded:

1. That maximum temperatures of crystallization of calcite may be approximately equivalent to the paleotemperature of the parent rock.

2. That the lowest limit of maximum temperature (160°C.) is favourable for migration of viscous oil.

3. That the highest limit of maximum temperature (400°C). is likely to destroy the hydrocarbons in the rock. The same conclusion can be drawn from Table 2 which shows that the temperature decreases gradually in rocks of Eocene age with respect to distance from Darband batholith except in case of Abylisk (Nicolson) 60 Km. north east of Khairi Murrat as shown in Fig. 3. From Table 3 it can be concluded that older the rocks in a normal sequence (or deeper the regions) higher temperature is observed.

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Reference

1. Kennedy "Symposium Earth's Crust," London (1950).