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The occurrence of turquoise and faustite in Tras, Pahang

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Abstract: This paper describes the occurrence of turquoise and faustite near the town of Tras in the Raub district, Pahang. It is believed to be the first occurrence of turquoise and faustite in Peninsular Malaysia. The faustite occurrence in the Tras area is probably the second known locality of faustite in the world. The first documented occurrence of faustite is in Copper King Mine, Maggie Creek district, Eureka County, Nevada, U.S.A. (Richard & Margaret, 1952). The turquoise and faustite were identified by X-ray diffraction study, and by chemical analyses. The minerals were found in fractured chert belonging to the "Foothills" (Haile *et al.*, 1977) group of rocks which are probably of Devonian age.

INTRODUCTION

In April 1984, whilst the writer was on his way to Raub on vacation, he spotted some green and bluish-green minerals on a road cutting about 2.4 kilometres northeast of the town of Tras. The bluish-green mineral was later identified as faustite and the green mineral as turquoise. The co-ordinates of this locality are 3°45' 20"N and 101°49' 30" E, (See fig. 1).

Turquoise is commonly known to occur near to the ground surface as a secondary mineral (Dana, 1961). It is usually found in areas with arid climate (Webster, 1962). Gem quality turquoise ranges in colour from green to sky blue and is commonly used as beads, cabochons, talismans and ornaments. Small chips and pieces of turquoise are commonly used by Indian workers and silversmiths for inlay or embossment for decorative purposes.

Turquoise is a 'sensitive' mineral for its colour usually changes and/or fades when exposed to sunlight, heat, soap, perfumes and detergents. The finest gem material comes from Iran. The oldest turquoise mines known are in the Sinai Desert. Small amounts of turquoise are found in Egypt, China, Australia, Tibet, Peru, Mexico, Chile, Afghanistan and Pakistan. Today the principal source of turquoise comes from the United States of America, with most of her mines in the states of Arizona and New Mexico.

The first occurrence of faustite was associated with montmorillonitic clay. It was discovered as an apple-green vein filling and as compact masses in altered shale and chert rocks at Copper King Mine, Maggie Creek district, Eureka County, Nevada in the United States of America. The mineral was named in honour of George T. Faust of the United States Geological Survey (Richard *et al.*, 1952).

Faustite which is a zinc aluminum phosphate $(Zn_8\ Cu_2)\ Al_6(PO_4)4(OH)_8$ $.5H_2O$, (Richard & Margaret., 1952) is similar to turquoise except for the

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presence of considerable zinc content. It usually occurs as hard compact masses nodules and vein fillings. The masses and nodules usually are smooth when felt with the hand and has a conchoidal to smooth fracture. The mineral is brittle and the hardness is 5½ in Moh's scale. The specific gravity is 2.92 and the mean refractive index is 1.61.

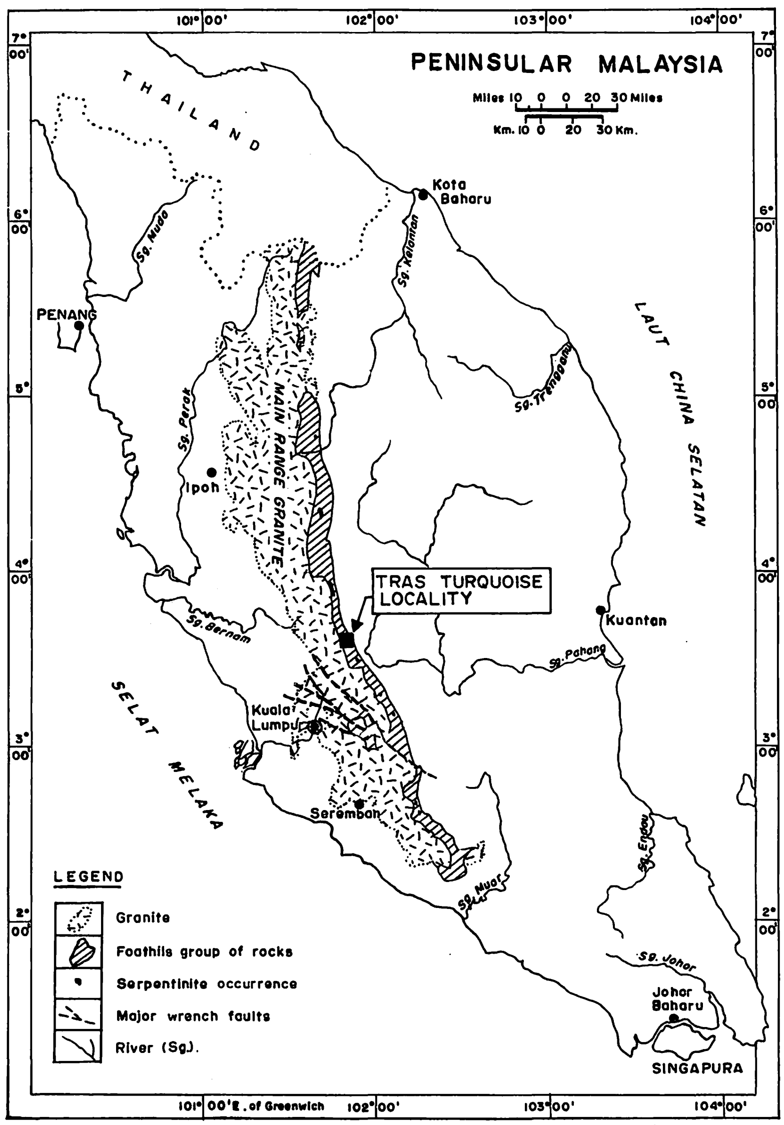

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Figure 1 : Map showing the Tras turquoise locality within the "Foothills".

GENERAL GEOLOGY

The turquoise and faustite are found as veinlets varying in thickness from 2 - 5 mm., and extend to about 1 meter in length, and are present as amorphous forms or in botryoidal masses. They occur in highly fractured and brecciated iron-stained chert. At places, the minerals occur as infillings along fractures and

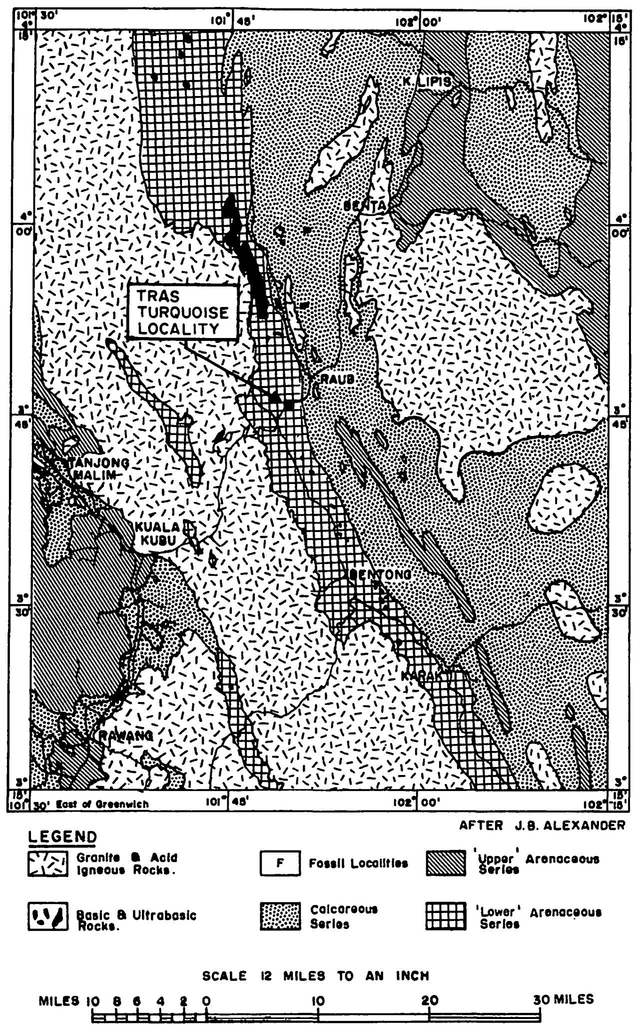

Figure 2 : Part of geological map of Malaysia
showing the relation of the general geology surrounding the Tras area

joint planes of the rock. They are mostly confined to the chert bed which is in a fault zone of about 3.5 meters long and 0.9 meters wide trending about 010° and dipping 25° towards east. The adjacent country rock consists of weathered phyllite, brown shale, chert, and massive sandstone. The chert has a characteristic flinty black appearance. It breaks easily into angular fragments when weathered. The fresh chert is usually very hard and breaks with a conchoidal fracture. Some of the chert is disseminated with pyrite and contains radiolaria and other organic remains. Structurally, the rocks are tightly folded.

The rocks belong to the "Foothills" (Haile *et al.*, 1977) group of rocks which are probably of Devonian age. About 40 kilometers southeast of this locality, fossils such as graptolites, crustaceans, brachiopods and sponges have been found in the Foothills Formation which are found near the towns of Karak, Manchis and Jelebu. The rocks in these areas are dated as Early Devonian in age (Jaafar, 1976).

MINERALOGY OF THE TRAS TURQUOISE AND FAUSTITE

The colour of the turquoise is bluish-green and in some places it is apple-green. The mineral is porous subtranslucent to opaque, cryptocrystalline and has a conchoidal fracture. The lustre is slightly waxy. It has a whitish to a pale-green streak. The specific gravity is 2.6 to 2.8 .

The turquoise was found to be a hydrated phosphate of copper, zinc and aluminium. It forms an isomorphous turquoise - faustite series. Turquoise is the copper-end member whilst faustite is the zinc-end member.

In thin section the turquoise and faustite appears as sheaf-like groups of crystals and have low birefringence (see Figs. 3, 4 & 5) The petrographic features are not characteristic enough to confirm turquoise and faustite in thin section. A complete determination of the optical properties of the minerals could not be made owing to the small particle size.

The mineral was identified by X-ray diffraction and chemical analyses. The results of the chemical analyses of the green and bluish-green turquoise varieties are given in Table 1. The host rock (chert) was also chemically analysed (see Table 2).

Two varieties of turquoise have been identified with the chemical results as shown in Table 1:

(a) a green variety which has a higher Cu/Zn ratio, and

(b) a bluish-green variety which has a lower Cu/Zn ratio.

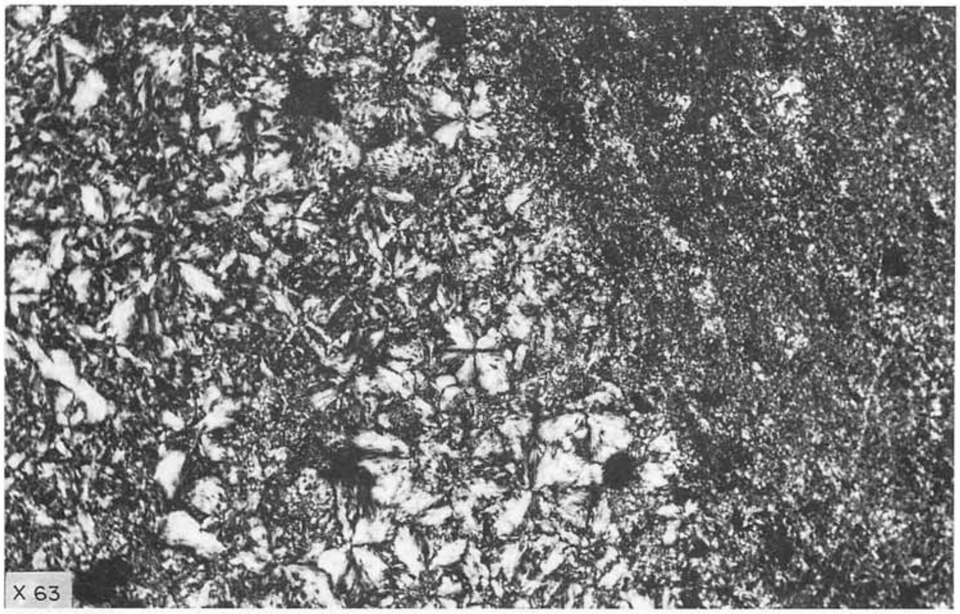

Figure 3: Turquoise in contact with chert between X - nicols.

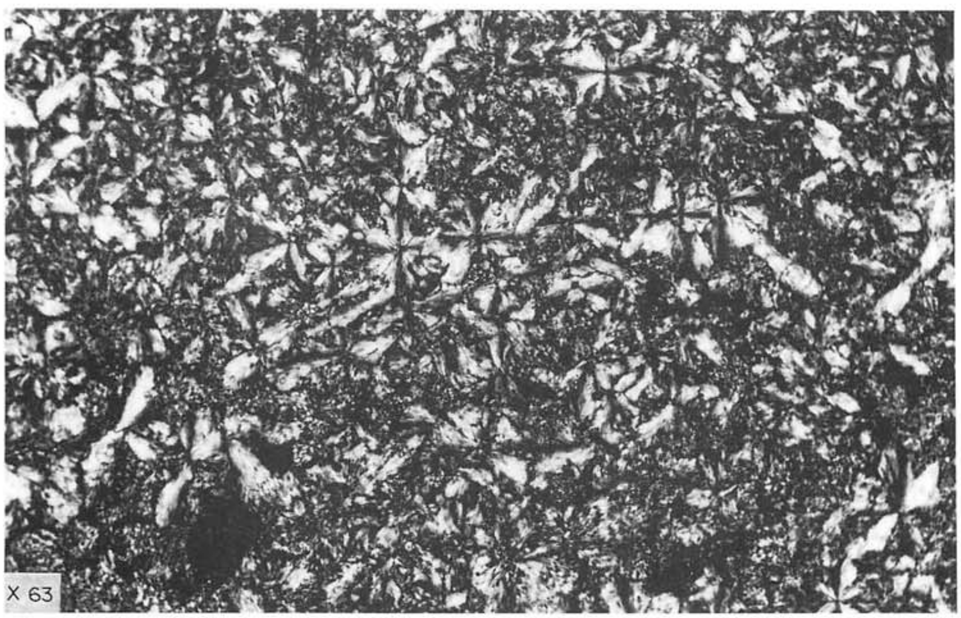

Figure 4 : Turquoise between X - nicols.

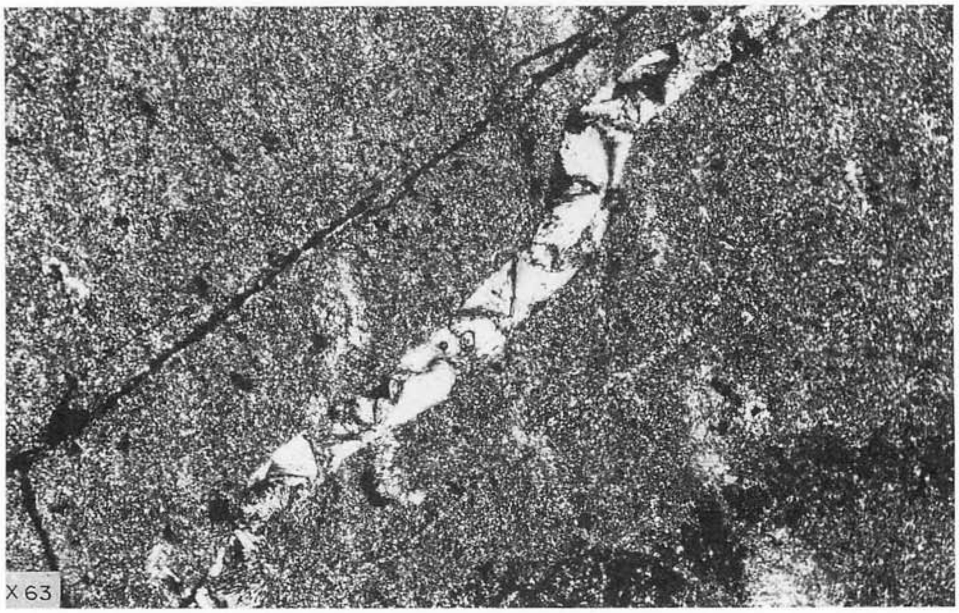

Figure 5 : Turquoise veinlet in radiolarian chert between X - nicols.

Table 1. Analyses of the Tras turquoise

Hand-picked	Sample No.I (green variety)	No. 2 (bluish variety)
$-H_2O$	0.64%	1.08%
$+H_2O$	19.60	18.82
Al_2O_3	40.25	41.05
P_2O_5	36.93	37.09
CuO	2.33	1.27
ZnO	0.71	0.64
SiO_2	0.02	less than 0.01
Fe_2O_3	less than 0.01	less than 0.01
Total	100.48	99.96

Analyst: Encik NG WENG KWONG

Table 2. Analyses of chert rock

% SiO_2	91.0	ppm Cu	753
Al_2O_3	3.34	ppm Pb	less than 5
Fe_2O_3	0.74	ppm Zn	275
FeO	trace		
TiO_2	0.02		
P_2O_5	2.39		
MnO	trace		
MgO	0.06		
CaO	0.24		
Na_2O	trace		
K_2O	trace		
LOI	2.04		
* Others	0.13		
% Total	99.96		
% H_2O^+	1.23		
H_2O^-	0.39		

Trace = less than 0.01 %

* inclusive of CuO & ZnO only.

Analyst : Encik LEE KIM HOCK

POSSIBLE SOURCE OF TURQUOISE AND FAUSTITE

The source of the Tras turquoise and faustite which are secondary minerals are thought to have originated from the radiolarian chert and possibly from other organic remains (graptolites,sponges, foraminifera, crinoids, brachiopods and crustaceans) which could be the source of phosphorus present in the "Foothills" group of rocks. Turquoise could also have originated from the break down of aluminium rich rocks at the environs of copper related sulphides. Chalcopyrite, bornite, brochantite, sphalerite have been reported in the surrounding area by the writer and previous geologists. These rocks, minerals and organic remains might have undergone decomposition and intensive alteration as a result of tectonic activity in the area. The copper, phosphorus and alumina may then have been carried down in solution, deposited along the heavily fissured chert along the joint planes to form the turquoise.

RECOMMENDATION

It is recommended that the "Foothills" group of rocks in and around Tras and elsewhere be investigated for the possible occurrence of economic deposits of turquoise, phosphate and other mineral deposits.

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Table 3. Known distribution of turquoise in principal countries.

Country & Area	Type of Deposit	Colour	Possible Source Rock
Persia/Iran	Narrow seams/irregular patches. Associated with limonite	Fine blue	Porphyritic trachyte
Egypt / Sinai	Veins and infillings of cracks Some associated with ferruginous sandstone	Yellowish-green & greenish - blue	Sandstone / porphyry
U.S.A. In the States of Santa Fe, New Mexico, Arizona, California, Colorado, Nevada & Texas	Nodular masses,veins. Some associated with limonite	Blue & green	Trachytic rocks

Table 4. Identification table of turquoise and other coloured minerals resembling turquoise

Name	Density.	Refractive Index	Hardness	Crystal System
Turquoise	2.6 - 2.85	1.61 - 1.65	$5^1/_2$ to 6	Triclinic
" American	Approx. 2.6	1.61 - 1.65	$5^1/_2$ to 6	"
" Persian	Approx. 2.8	1.61 - 1.65	$5^1/_2$ to 6	"
" Egyptian	Approx. 2.8	1.61 - 1.65	$5^1/_2$ to 6	"
Variscite	2.4 to 2.6	1.56 (mean)	5	Orthorhombic
Odontolite	3.0 to 3.1	1.57 to 1.63	5	Amorphous
Amazonite	2.56 to 2.58	1.52 - 1.53	$6^1/_2$	Triclinic
Chrysocolla	2.0 to 2.45	1.50 (mean)	2 to 4	Fibrous & cryptocrystalline
Brochantite	3.9 to 4.0	1.72 - 1.80	$3^1/_2$ to 4	Monoclinic
Faustite	2.76 to 2.92	1.61 (mean)	$5^1/_2$	Triclinic

Table 5. Some colouring metals of turquoise and turquoise - like mineralas

Mineral	Colour	Composition	Colouring Metal
Turquoise	Blue to green	$CuAl_6(PO_4)\ 4(OH)_8.\ 5H_2O$	Copper
Faustite	Apple green to bluish green	$(Zn_8Cu_2)\ Al_6(PO_4)\ 4\ (OH)_8.\ 5H_2O$	Copper
Variscite	Green to bluish-green	$AlPO_4.\ 2H_2O$	Iron
Odontolite	Blue	Bone or tooth fossil ivory	Iron
Amazonite	Green to bluish-green	$KAlSi_3O_8$	Iron
Chrysocolla	Greenish-blue to green	$CuO.SiO_2.\ 2H_2O$	Copper
Brochantite	Vivid green to blackish- green	$Cu_4(SO_4)\ (OH)_6$	Copper

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