that incubation for 2 hours at 37° C. increases the segregation rate and incubation for 3 hours has no definite advantage. There is not a marked difference in the percentage segregation of 14-days-old and 30-days-old heterokaryons. It is interesting to mention here that all the three heterokaryons tested are balanced ones in the sense that they contain nearly equal number of component strains. The high percentage of segregation in older heterokaryons suggests that the heterokaryotic state is very unstable.

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Madras, July 29, 1968.

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AN ESTIMATE OF ALGIN-BEARING SEAWEEDS IN THE GULF OF KUTCH

Attempts to estimate the quantity of algin-bearing seaweeds in India* have so far been restricted to two small areas. Extensive growth of *Sargassum* spp., which form the main source of algin in India, were observed in the Gulf of Kutch area and we decided to start our survey there. Six stations, Dera, Goos, Narara, Sika, Karumbhar and Baida were selected for carrying out the survey in the first instance. Earlier work in our laboratories showed that the yield and quality of algin were superior in weeds collected during the winter months and so the work was carried out during the period of November 1967 to January 1968.

The estimate was based on random samples over fairly large sections of coastal waters and the method of sampling as well as calculation of the estimated quantity of seaweed were similar to those of Walker. The sampling stations, total area surveyed in each sampling station and the estimated quantities of total seaweeds, *Sargassum* spp., and other algin-bearing weeds are given in Table I.

Altogether 10.65 km. of coastal waters were surveyed and a total of 18,785.5 metric tons of seaweeds were estimated in these areas. Of this quantity, *Sargassum* spp. account for 12,010.5 tons. There were only two species of *Sargassum* involved, *S. tenerrimum* and *S. cincereum* and the first named species was the most abundant. As it has been found by one of us (V. D. C.) that the life span of *Sargassum* on the Gulf of Kutch was generally two years and was probably never more than three years, it would be desirable to harvest only one-third of the available weeds in any one year so that full regeneration of the standing crop was facilitated. Even so, about 4,000 metric tons of fresh *Sargassum* can be harvested each year in the Gulf of Kutch alone, a quantity which is sufficient to produce about 80 tons of alginic acid.

We wish to thank Dr. D. S. Datar for his kind interest and the Department of Fisheries of Government of Gujarat, Ahmedabad, for their help in carrying out this survey.

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Blavanagar, July 31, 1968.


CO-EXISTING PYROXENES FROM PYROXENE GRANULITES

While surveying an area of about 60 square miles around Chimakurti (Guntur District, Andhra Pradesh), Lat. 15° 35'-15° 42' N and Long. 79° 47'-79° 53' E, pyroxene granulites (basic division of the charnockite series) represented by gabbro, norite, hornblende norite, etc., were noticed along with paragneisses and quartzites. In the present account an attempt

<table>
<thead>
<tr>
<th>Section</th>
<th>Area (sq. km.)</th>
<th>Total seaweeds</th>
<th><em>Sargassum</em></th>
<th>Other algin weeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dera</td>
<td>1.55</td>
<td>2301</td>
<td>1400</td>
<td>520</td>
</tr>
<tr>
<td>Goos</td>
<td>3.00</td>
<td>7300</td>
<td>5650</td>
<td>1720</td>
</tr>
<tr>
<td>Narara</td>
<td>4.00</td>
<td>5920</td>
<td>2720</td>
<td>480</td>
</tr>
<tr>
<td>Sika</td>
<td>0.50</td>
<td>1200·5</td>
<td>1120·5</td>
<td>33</td>
</tr>
<tr>
<td>Karumbhar</td>
<td>0·10</td>
<td>175</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Baida</td>
<td>1·50</td>
<td>1710</td>
<td>1080</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE I**

Estimate of algin-bearing seaweeds on the Gujarat coast
is made to bring out the significance of co-existing pyroxenes (ortho- and clino-) from the pyroxene granulites.

Hess\(^1\) has shown that the co-existing pyroxenes from the igneous rocks, when plotted on the En–Fs–Wo diagram, the projections of the joins of the pairs of pyroxenes intersect the En–Wo side of the triangle at positions approximating to Wo\(_{75}\). Muir and Tilley\(^2\) have indicated a similar relationship for the co-existing pyroxenes in the metamorphic assemblages. Wilson\(^3\) employed the tie line intersection of pyroxenes on En–Wo side of the En–Wo–Fs triangle, in distinguishing the mobilised granulites which fall close to Wo\(_{75}\) from the pyroxene granulites of the amphibolite facies, which fall close to Wo\(_{82}\). Wilson’s conclusions were criticised by O’hara\(^4\) and by Brown\(^5\) who have pointed out the discrepancies between compositions obtained by optics and by chemical analyses. From the discussion it is clear that tie line intersections at about Wo\(_{75}\) may not help in distinguishing the igneous pyroxenes from the metamorphic pyroxenes (irrespective of whether the compositions are obtained from chemical analyses or optical data).

The three pairs of pyroxenes (ortho- and clino-), whose analyses are not given here, when plotted on the En–Fs–Wo diagram (Fig. 1) have shown their tie line intersections at Wo\(_{73}\) for two pairs and at Wo\(_{71.5}\) for another pair. A similar positioning of the tie lines was obtained for the pyroxene pairs of the Madras charnockite series (Howie\(^6\)). Howie\(^6\) states that such positioning of the tie lines is true for all pyroxenes which have crystallised under equilibrium conditions.

The recent investigations of Mueller\(^7\) and Kretz\(^8\) and Bartholomé\(^9\,10\) show that the distribution coefficient \(K_p\) (Mg–Fe) of pyroxene is a useful parameter in distinguishing the igneous pyroxenes from metamorphic pyroxenes. The three pairs have given values 0.502, 0.613 and 0.527 for gabbro, hornblende-norite and biotite-norite respectively. The average of these three works out to be 0.544; almost the same value (0.54) was obtained for the Madras charnockites also.

It has been noted by Kretz\(^10\) that there is a distinct tendency for the distribution coefficient to lie near the value of 0.54 or 0.73, representing mineral pairs from supposed ‘metamorphic’ rocks and ‘igneous’ rocks respectively. Kretz\(^8\) from thermodynamic considerations arrived at the conclusion that the distribution coefficient \(K_p\) is a function of temperature and pressure and is independent of chemical variations. Binns\(^11\) from the study of the Broken Hill pyroxenes shows that the distribution coefficient is not invariant under constant temperature and pressure conditions, but depends on composition. In the present state of our knowledge, it is not possible to know whether \(K_p\) is controlled by P–T conditions or by composition, until more analytical data are available for pyroxene pairs of known paragenesis.

Rocks which are considered as metamorphic rocks, but having high \(K_p\) values are explained by Kretz\(^10\) that they were once igneous rocks, which were subsequently recrystallised at ‘metamorphic’ temperatures but whose distribution coefficient remained unchanged during this operation. Such rocks were crystallised originally near liquidus temperatures. But rocks having \(K_p\) values around 0.54 have not crystallised near liquidus temperatures, but are formed at much lower temperatures. A temperature of about 670°C was given by Howie (Kretz\(^10\)) for Madras charnockites which have an average \(K_p\) value of 0.54. Same value is obtained for the charnockites of the present area and hence temperature given by Howie holds good for the rocks of the present investigation.

The investigation of the co-existing pyroxenes indicates the equilibrium conditions for the pyroxene granulites. The distribution coefficient of Mg and Fe further shows that the pyroxene granulites are formed at 670°C.
Letters to the Editor

The writer wishes to thank Professor M. G. Chakrapani Naidu for his guidance and Dr. M. S. Murty for critically reading the manuscript and suggesting improvements.

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OCCURRENCE OF PYRRHOTITE AND CHALCOPYRITE IN KASIPATNAM, ANDHRA PRADESH

In the course of recent investigations in Kasipatnam area (18° 17" N: 83° 09" E.), Andhra Pradesh, an occurrence of pyrrhotite in association with apatite-magnetite veins was noticed. Thin section study revealed that the material in which pyrrhotite is found is essentially ferrosalite. Pyrrhotite occupies the weaker zones of ferrosalite in the form of small veinlets and segregations (Fig. 1). Along the contacts of pyrrhotite and ferrosalite, and also along cracks and cleavage planes of pyrrhotite, small veinlets and disseminated grains of chalcopyrite occur.

Pyrrhotite has been identified from its bronze-yellow colour, tendency to get tarnished in air, strong magnetic property and easy solubility in hydrochloric acid with the liberation of hydrogen sulphide. The above mineral assemblage was studied under an ore microscope and megascopic identification of pyrrhotite was confirmed from the brownish cream colour with high reflectivity, faint pleochroism in oil, and etch reaction with KOH which tarnishes the mineral to iridescent brown. Chalcopyrite was identified from its brass-yellow colour with noticeable faint pleochroism. In association with pyrrhotite and at its edge, a small blade-like form with cubic cleavage is noticed. From its high reflectivity, white colour, and etch reactions (negative to KOH, temporary brown stain with aqua regia, and lack of effervescence with HNO₃, which gives a temporary brown stain), this has been identified as pentlandite (Fig. 2), an iron-nickel sulphide, which usually occurs in association with pyrrhotite.

Figs. 1-2. Fig. 1. Pyrrhotite (Pyr) vein in ferrosalite (Fs). Polarized illumination, × 10. Fig. 2. Pentlandite (Pent) and pyrrhotite (Pyr) in ferrosalite (Fs). Polarized illumination, × 30.

The apatite-magnetite veins are found along the NW-SE joints of biotite-gneisses which strike NE-SW. The veins often exhibit zoning-features resembling igneous zoning in pegmatites. Ferrosalite forms the outer zone followed by inner apatite zone with or without intermediate vermiculite zone. It is believed that the ore-bearing solutions started migration after the stage of apatite formation, and occupied the fractures and other such spaces available in already congealed ferrosalite zone. The ore-minerals exhibit replacement relationship with ferrosalite. The first ore-mineral to be formed is believed to be pyrrhotite, followed by chalcopyrite which replaces the former preferably along the cleavage planes. Pentlandite is believed to