Farnham Geological Society

(A Local Group within the Geologists' Association)

NEWSLETTER JULY 1991

Dec3- No 7

June is nearly over and we have yet to see real summer. For the Society the highlight of the year must surely be our recent field trip to Northern England for which we are greatly indebted to Peter Cotton and the local leaders,and certainly to Mike our coach driver who took us through several angustiae without even scratching the paintwork. Peter can in no way be held responsible for the weather which later steadily deteriorated. We did not actually get snow but on the last day we experienced horizontal rain at about 0 degrees C.

Some of us Southerners had been led to believe Northumberland to be cold, bleak and cheerless. Instead, on our way to Lindisfarne, we met pleasantly rolling countryside with lush fields and plentiful trees in all their summer finery, and the small town of Alnwick, where we made a brief stop, with all the buildings of mellow buff sandstone, wholly delightful. And the sun shone bravely over Lindisfarne.

A full report will appear in our next Newsletter. For the present issue we must thank Marybeth Hovenden, Kate Jemmett and John Williams.

We offer our hearty congratulations to Marjorie Outlaw on gaining a B.A. degree from the Open University.

The second and concluding part of John Williams' article will appear in the next Newsletter. Considerations of space prevent us from printing the full petrological details of the very complex island of Mauritius. These, together with the bibliography, may be examined on application to the Newsletter Editor.

David Caddy (editor).

DAY SCHOOL ON SANTORINI AT BRISTOL

Fog blanketted the City of Bristol and filled the Avon Gorge one Saturday in December when a group of 100 people met at Bristol University to discuss warmer topics. The subject of the day school was "Current Research on Santorini,"and five experts had agreed to reveal the latest theories and present state of knowledge on this enigmatic subject. For those of us, perhaps everyone present, who had stood on the lip of Santorini crater, and pondered the immensity of the Prehistoric explosion needed to create such a vast Caldera. and to destroy a civilized society of great charm, expectations ran high!.

The five speakers had all managed to arrive, and Dr Peter Hardy introduced them.

Firstly, Sinclair Hood, an archaeologist, outlined the general history, and explained the two theories current concerning the type of city Akrotiri, the main archaeological site, might have been. Was it been a colony of Crete, or had it an indigenous culture? He quickly listed 5 or 6 reasons for his belief that the culture was the same as on Crete. He reminded us of the wonderful frescoes found at Akrotiri.

Secondly, Professor Peter Warren addressed himself to the question of dating the eruption of Thera, which buried that same city, and covered all traces of that civilization, until German excavations began in 1890. He generously gave unpublished information from recent excavations in northern Crete and Rhodes, though scant, which would indicate a time falling after late Helladic I and before late Minoan IA(the period must still be dated by relative pottery styles, rather than with exact dates.) He next explained 2 other methods of dating, first referring to the absolute date announced in "Nature", as reported in "Geology To-day", vol.3 no.6 Nov/Dec 1987, from an ash core in Greenland. He discounted the 1644 +/- 40 years B.C. date. He believed that the span of time that the ash layer would have taken to accumulate did not correspond to the time that ash would have been in the atmosphere: i.e. that the Mediterranean evidence of the eruption showed it had happened either in a few tens of hours or up to 4 days. Then from counting frost-damaged tree rings found in the Bristle-Cone pine of California, and Bog-Oaks found in Iceland, he said a date of 1628 B.C. had been reached, a time when a notable lowering of temperature in temperate climates had occurred.

But was there any evidence to pin-point the eruption of Santorini as the cause? There is some evidence that other volcanoes, i.e. the "Avolino" eruption of Vesuvius, or the "YN" eruption of Mt St. Helens, might have accounted for it. As for radio-carbon dates, 3 universities, Oxford, Cambridge and Simon Fraser University, Vancouver, Canada had co-operated in an analysis of 26 samples of organic material, but imprecision caused widely differing results. When Simon Fraser came up with a method of removing contaminates, the others doubted their accuracy but a date of 1619 B.C. was postulated as the most probable date.

Using correlations with a date scale widely accepted for Egyptian chronology, the nearest postulate would be Late Minoan IA, about the Second Intermediate Period in Egypt.

The third speaker, Dr Rupert Housley from Oxford University, expanded on the experiments to carbon-date,done by the 3 afore-mentioned Universities. He pronounced a 70% chance of the date falling between 1700 and 1600 B.C. He spoke of the multi-national conference held on Santorini in autumn 1989 in which he and other speakers participated, and advertised the publication of the papers given. Volume 1 he had in his hand. Volumes 2 and 3 would follow shortly. The price would be £150 total.

After a break for lunch, we heard Dr Mike Baillie from Queen's University, Belfast, speak on dendro-chronological advances and their implications for the Santorini event. Would he turn the previous dates on their heads? In a wide ranging grasp of evidence from many cultures as far-afield as the Shang Dynasty in China which ended in 1600 B.C. he cited catastrophic events that brought notable human hardships, packages of events that resulted in famines, plagues and "dark ages" in many places World-Wide. Could these have been "dust-veil" events? the effects of more than one event? or the effect of multiple eruptions? The evidence for "bad years" was well collated in tree ring dendro-chronology. He was confident that the technology now exists finally to answer the date question.

The last speaker was Professor Steven Sparks, present Head of Geology at Bristol University, and it was his endeavour to give us geological evidence for the Santorini eruption. It is no longer believed that there was one great volcanic peak that erupted in one event to give us the present caldera. Instead, we know that there was a water-filled structure there before the eruption in Minoan times, probably with an island in the centre. We know it had probably erupted a dozen times, major eruptions with caldera collapse. In the cliffs around the present caldera can be seen the older sequences, with repetitive cycles, the pinky layer deposited about 200,000 B.P. the white layer, about 100,000 B.P., the dark layer about 18,000 B.P.

He then specified what we know of the Minoan eruption. The estimated volume of volcanic material erupted was 30 cu. km., the estimated time of its eruptive activity 3 or 4 days at most, and the rate of eruption increasing with time. In phases, then, the first phase, possible earthquakes, few pre-cursor eruptions, heated ground waters, also a Plinian discharge of angular and rounded lumps of white pumice, 30 to 35 km. high. Then a pulse-like second phase erupting very fine-grained material, with a base surge, and abundant sea water entering the vent. The third phase, violent, rapid flows, carrying massive blocks, with very little sorting or structure. The fourth phase, pyroclastic flows of pumice and ash deposited hot lower down slope, seen to-day on coastal flows all around the island, and adding 1 km. to the coast in some places. The evidence for deposits in Eastern Crete, he said, are 1 or 2 cm. only(though Rupert Housey had other evidence.)

Then placing it in the context of other world eruptive events, he mentioned 5 as large or nearly as large events in the past 200 years, and said this was a pretty typical rate through time, and comforted us with the thought that the effect these big eruptions had on Global weather and associated problems usually lasted, at worst, a couple of years. This seemed to indicate to us that the demise of the rest of the Minoan civilization could not be blamed upon one eruptive event in Santorini.

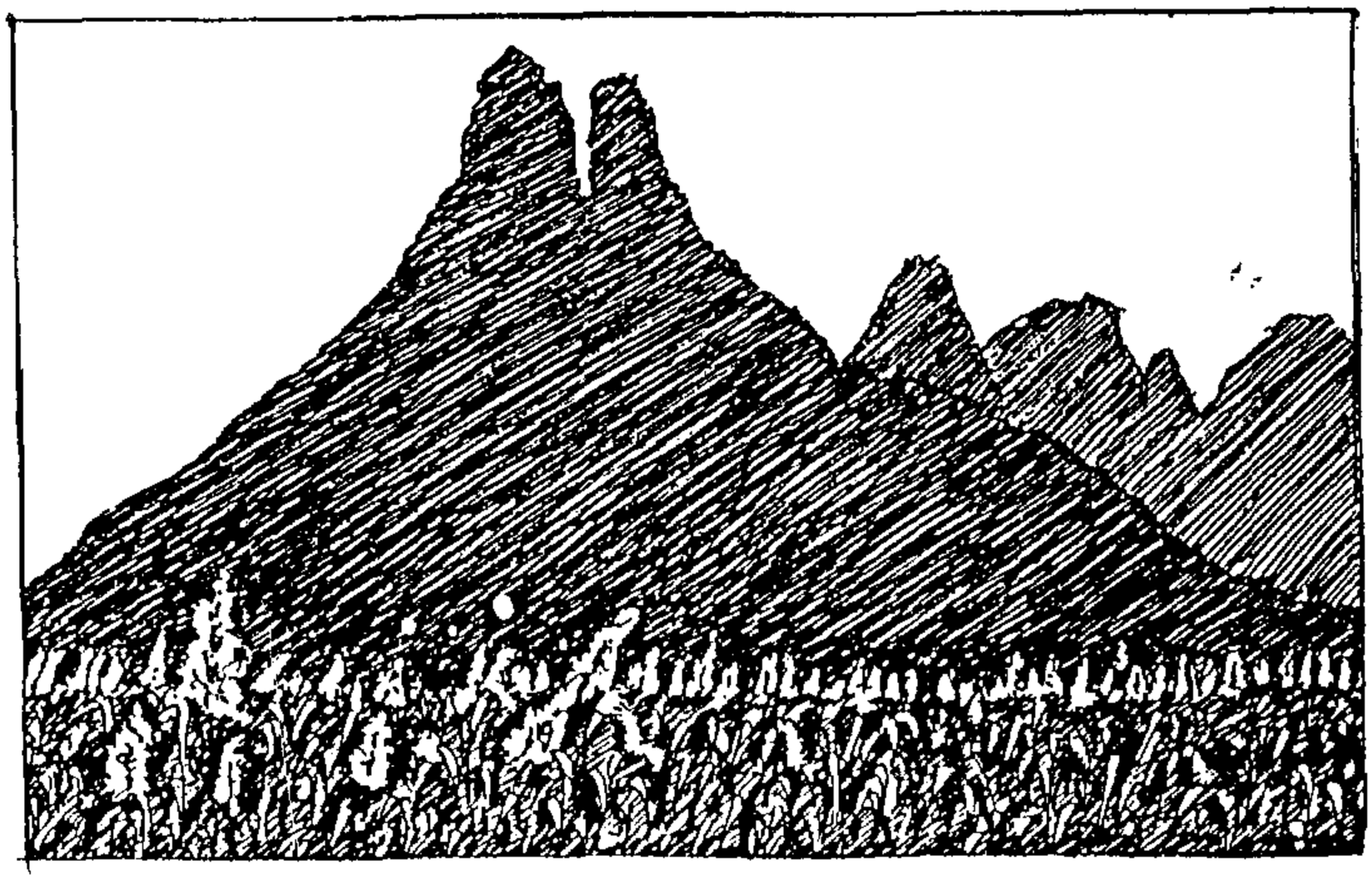
At question time, queries came about analogies made with Krakatoa, the core layer taken from the sea bed of the Mediterranean, the cliffs on the northernmost part of the crater, and the Greenland ice-core sample.

Lastly, Professor Warren removed his support for the early 17th century B.C. dates on the evidence of the three avenues of scientific investigation! Back where we started! As we emerged into the darkness of the city, we were buzzing with further questions, and grateful for a day spent pondering such intriguing matters.

Marybeth Hovenden.

THE ÎLE DE FRANCE - SOUTH OF THE EQUATOR

We flew to Mauritius from Nairobi via Antananarivo across 'The Great Red Island', which looks like Africa and according to plate tectonic theory was formerly part of that continent. Our approach was over — seemingly endless, lush, vividly green fields, presumably of sugar cane, contrasting with the blue Indian Ocean; but what were those strange random circles, a different green and not displaying the completely even texture of the plantations?



Le Piton du Milieu at sunset .

Mauritius is one of the group of islands named the Mascarenes, Although known to the Arabs, they were'discovered' by the Portuguese explorer Pedro de Mascarenhas in the late 16th century. The other islands are Réunion and Rodrigues; in the past Mauritius always attracted the most political interest and thus has had a diverse history. These islands lie on an oceanic plateau which is separated from Madagascar by a deep trench of at least 4000 metres and they are all totally volcanic in origin. (Fig 1).

The Portuguese had no colonial aspirations but used the island as a staging post en route for the East Indies. They introduced domestic farm animals and together with rats from their ships, triggered the ultimate demise of the dodo, which was also heavily hunted. In the early 17th century, a small group of Dutch, with their slaves, arrived from the Cape of Good Hope and started a colony. They grew sugar cane and exploited the island's natural resources to the hilt so that in less than a century the superb ebony forests had disappeared. Frequent cyclones and slave mutinies provoked them to abandon the settlement.

The Dutch had named the island Mauritius in honour of Prince Maurice of Nassau, but when the French, as the East India Company*, occupied the island in 1715, they called it the Île de France. The French constitution and legal system were introduced, and economically the island flourished on the production of sugar cane, for whose cultivation very large numbers of slaves were imported from Madagascar and West Africa: and by piracy. French-English rivalry was at its height, with the break-up of the Moghul empire in India and European colonialists wanting to stake their claim. Port Louis became a most prosperous haven for cross-Indian Ocean traffic, and after the East India Company was financially ruined at the end of the Seven Years War, the Ile de France was administered by civilian governors.

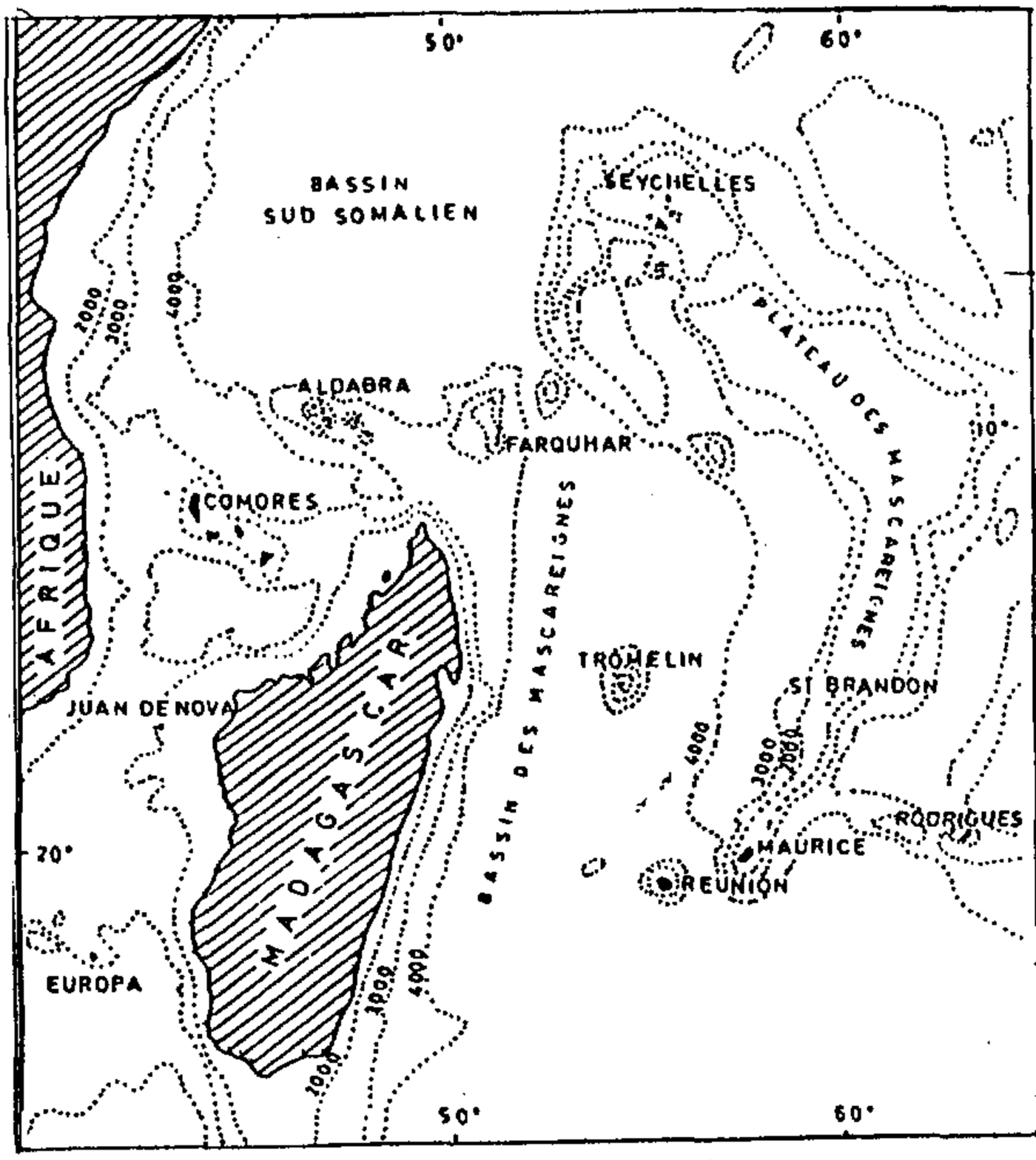


Fig 1. Bathymetric map of the Indian Ocean after Fischer (1967)

Towards the end of the 18th century, the British, who were by now well established in India, began to feel uneasy at the strong French presence in the middle of the Indian Ocean and in 1810, with a formidably strong naval force, they attacked the French islands. A heroic stand was made at Port Louis, but with a continuing blockade, General Decaen was forced to capitulate and the Mascarenes and the Seychelles became British. In the Treaty of Paris, Réunion was returned to the French and remains part of metropolitan France to this day.

The island is not very large (see next section) but within its shores there is surprising diversity. The east has high, rocky cliffs, the north and west have superb coves and beaches with coral reefs not far off-shore. The plateau of the south west region falls slowly away to a large area where sugar cane is grown; the ubiquitous lava boulders have been cleared and piled up in large heaps, 50ft or more in diameter and almost as high. The older ones have well established bushes and trees growing on them, and

* La Compagnie des Indes.

form those distinct circles when viewed from above. None of the mountains surrounding the plateau are very high but they have most dramatic shapes, and within the upland area, there are wild river valleys, gorges and waterfalls. Most of the original islanders decided that the climate of the plateau was more pleasant than the coast. They settled in Curepipe, Rosehill, Réduit often building in beautiful Creole style architecture. Curepipe's local park is the rim of a volcano, known as the 'Trou aux Biches'. with an all round view. Both the flora and fauna are highly diversified - there are several national parks and outstanding botanical gardens at Pamplemousses.

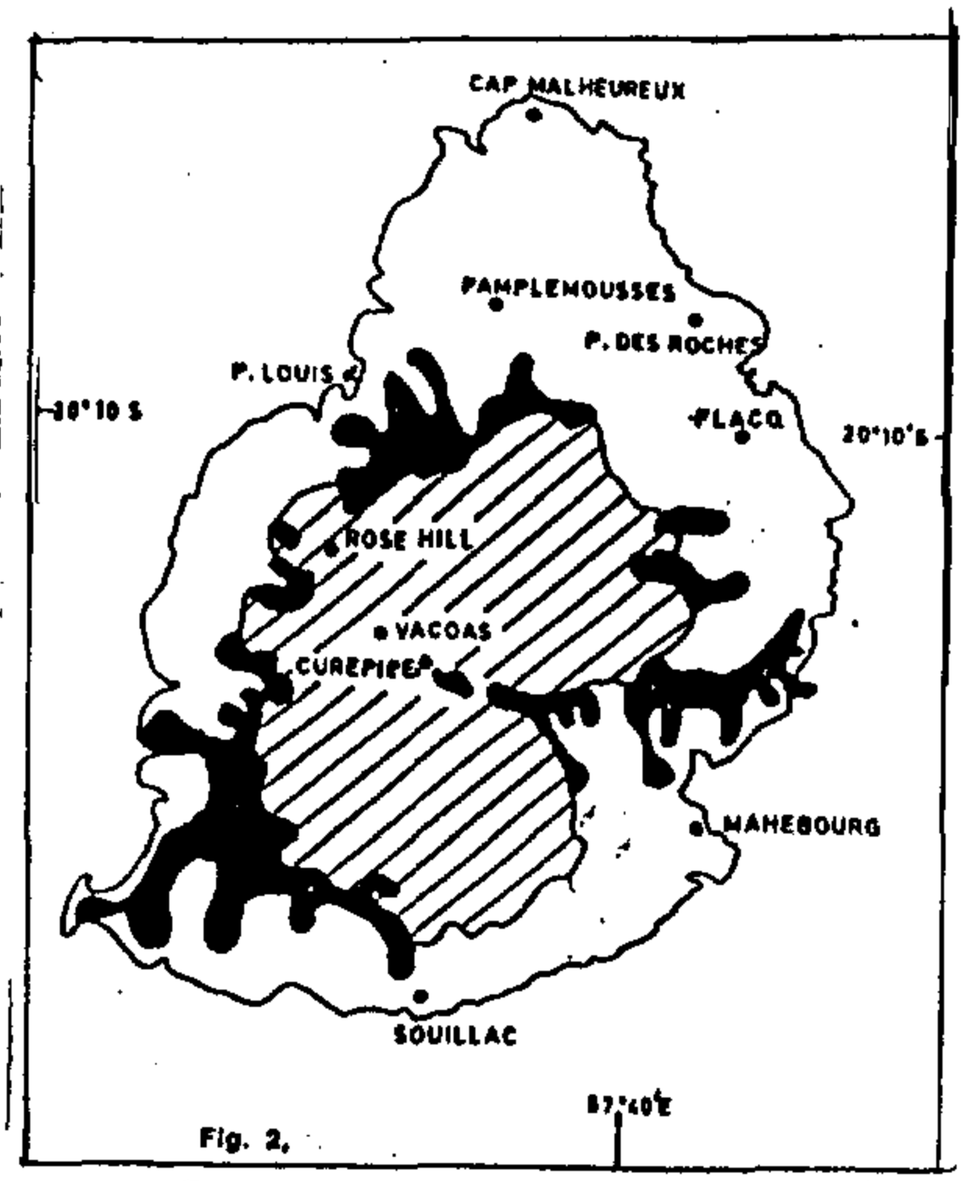


Fig. 2.

after P.Willaime (1984)
Fig 2. Mauritius showing general relief and main towns

Mauritius became independent in 1965 and today has a population of around one million. 80% are of Indo-African origin, 15% Chinese and only 5% of French descent. English is the official language, but French is the mode of general communication and the majority speak a Tamil dialect as their mother tongue. The Mauritians look forward to increased prosperity in the future. They lie between the riches of southern Africa and the strong economies of the Far East. As well as efficient production of sugar cane and a tourist industry, they have become in a short timespan producers of high quality textiles for the European and American markets. With uncertainties about the long-term effects of 1997 on Hong Kong, many Hong Kong Chinese have invested heavily in new factories, or even moved their business in total to Mauritius. So there is full employment and plans to attract capital in all forms, with a view to becoming a money market for the Indian Ocean region.

MAURITIUS - OUTLINE GEOLOGY.

Mauritius, situated at 57 13'E and 20 20'S , is about 60 km along its longest axis, which is co-linear with the Mascarene ridge. This ridge is regarded (by Fisher et al; 1971: McKenzie and Slater 1971) to have originated as a line of volcanic activity along the widening of an early Tertiary transform fault - the Chagos Fracture Zone.

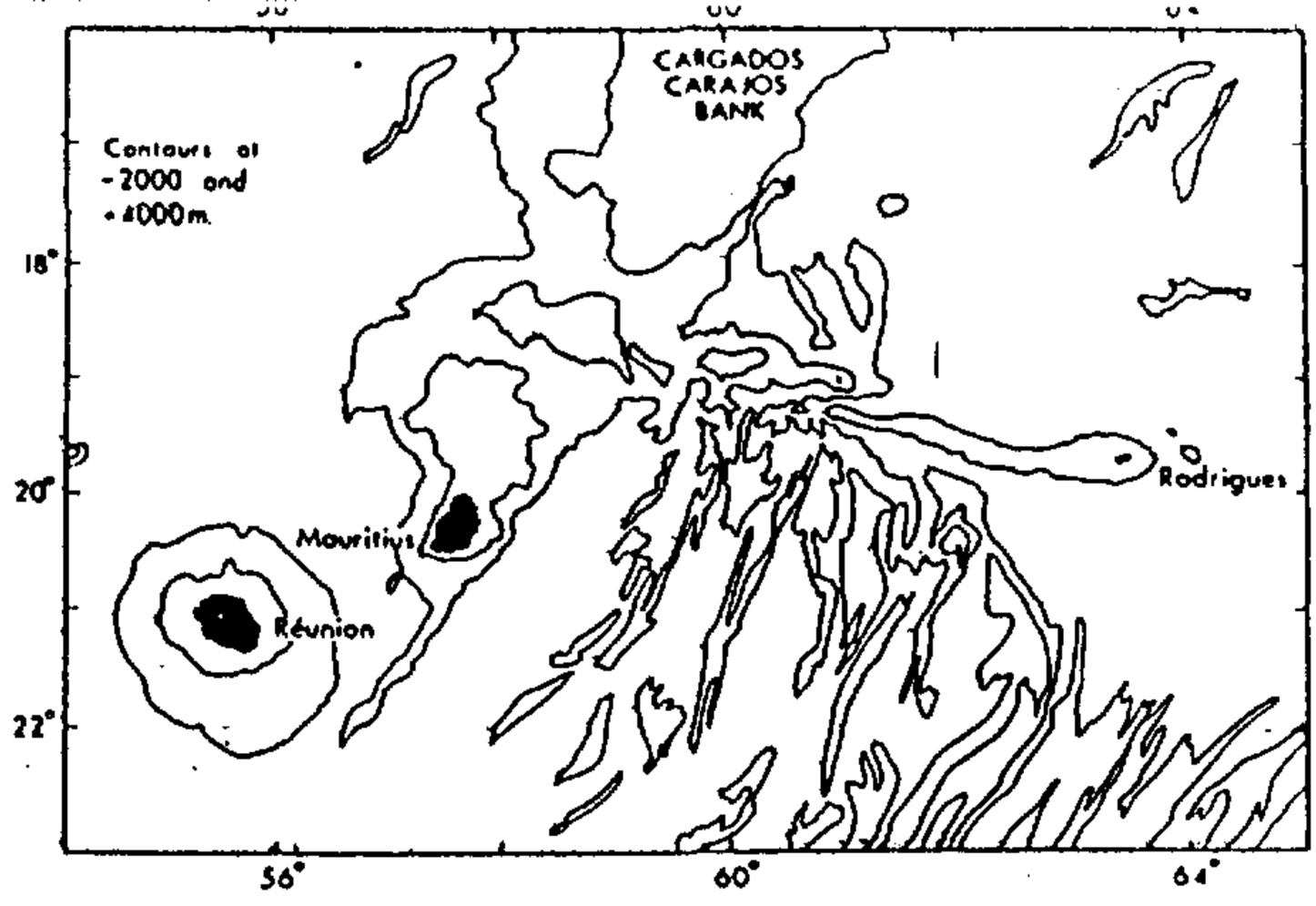


Fig.1

Map of the Mascarene Islands showing related oceanic depth contours (after Fisher et al. 1971)

Apart from small marginal coral reefs, the island is entirely volcanic and thought to have been formed from the summit of a very large central type volcano, whose base was 5 km down on the ocean floor, dated at 12 Ma. The sub-aorial cone grew in the early Pliocene (McDougall and Chamalaun 1969) and at around 5.5 Ma, the centre of the volcano is believed to have collapsed, forming a caldera which now forms the central plateau and accounts for the steeply inward facing slopes of the mountains, while sending long lateral spurs out to the sea. The lavas have been divided into three groups, based on chronology and chemical variation.

1. The Older Series

The 800 m. high mountains represent the remnants of the original volcano. The first stage of relatively alkaline lavas were erupted at about 62 Ma, dipping towards the coast. Then smaller quantities of largely similar lavas with radial dykes were erupted. Following a small erosional unconformity the second stage lavas filled the caldera and gave rise to such features as Piton du Milieu.

2. The Intermediate Series

After considerable erosion the intermediate series of basic lavas, of relatively small volume, were erupted. This stage started at about 16 Ma.

3. The Younger Series

These are considered to be early Pleistocene and represent fissure eruptions as they occur as a chain of small shield volcanoes running NNE-SSW. After the last eruption at about 26,000 years ago the lavas have been locally overlain by coral reefs.

The third excursion from Mount Carmel is a circular one which takes in Cedar Breaks and Kolob Canyon. It could be attached to the Bryce visit if sufficient time were available to you (and stamina). Leave Mount Carmel North along US89 and after 23 miles take the Scenic Route 14 West towards Cedar City. Try to estimate the age of the lava that you may notice as you travel through the pine forest. Take the turn-off North to Cedar Breaks National Monument. Make sure you have warm clothing even if it is 80° at Mount Carmel. The scenic drive here ends just beyond the turn-off to Panguilch. Scenic viewpoints and trails are on offer here, also a visitors centre which provide an opportunity to spend money on various momentos. Look out for marmots.

Return to the Cedar City road and continue Westwards. You will descend a spectacular gorge with opportunities to view Cedar Breaks from the bottom and to view the Morrison fault at close quarters. Cedar City is the first 'civilisation' that you will have experienced since Phoenix. Leave South by the I15 and take the turnoff to Kolob Canyon. Kolob Canyon is on the North-Westside of Zion National Park and well worth the climb to the end viewpoint - again you traverse the fault.

From Kolob continue South on the I15 and take signposted route to Zion Canyon via U17 Virgin and Springdale. The scenery may be familiar from Westerns you have seen on TV or in the cinema. This route provides an opportunity to detour and revisit Zion.

A quick aside about altitude - you will have spent a considerable time above any height that you can reach in the UK over the last few days. 7000ft on the South Rim, 8,200ft North Rim, 9050ft Point Imperial, 8500ft Bryce 10000ft Cedar Breaks. Fortunately the leisurely pace of this trip should have allowed you to acclimatise at height - but if you feel tired, exhausted, puffed, slightly heady, it could be the effect of the height. Move slower than normal - take frequent breaks - if at all doubtful do not carry out trail walking however enticing it may look and also remember that up takes at least twice as long as down but down stretches the legs and can be more painful on the knees.

ITINERARY 4
MOUNT CARMEL JUNCTION
US89 KANAB PAGE AZ98 KAIBITO AZ160 KAYENTA
ACCOMMODATION. KAYENTA OR MONUMENT VALLEY.

The next part of the tour retraces the route to Kanab then alongside the Vermillian Cliffs to the Grand Canyon Dam and Lake Powell. US89 all the way. Make sure you take a look from the scenic viewpoint just before the Dam and a stop at the Visitors Centre is a must. Do the self guided tour as well as take in the various exhibits and slide shows.

Take the road to Page and then the AZ98 past the Navajo Power Station, note that this is coal fired and is served by a railway. The scenery is very little different from that experienced previously on the route from Cameron northwards. You are running on the Northern edge of the Painted Desert. You might speculate on the method of power transmission and whether power lines should go underground. Join the US160 towards Kayenta and at AZ564 turn left for the Navajo National Monument.

The round walk to view the Betatakin site is well worth the effort and also the close up experience of a Hogan and a Sweathouse. There is a good Nature Trail with opportunity to examine at close hand specimens of flora with which you are about to come rather familiar.

Just prior to the turn off to the Navajo National Monument you will have passed a large silo with an enclosed continuous belt running up into the hills. This provides the coal for Navajo Power Station. Automatic trains run on a regular basis from the silo to the Power Station.

A few more mile along US160 brings you to Kayenta and the US163 which is the gateway to Monument Valley. Overnight accommodation is available in Kayenta. Kayenta is in the Navajo Reservation and provides one with the opportunity to be among the modern Indians. Supermarkets have replaced Trading Posts and pick up trucks have taken over from horses. However some traditions still remain, look out for Hogans as you pass their dwellings.