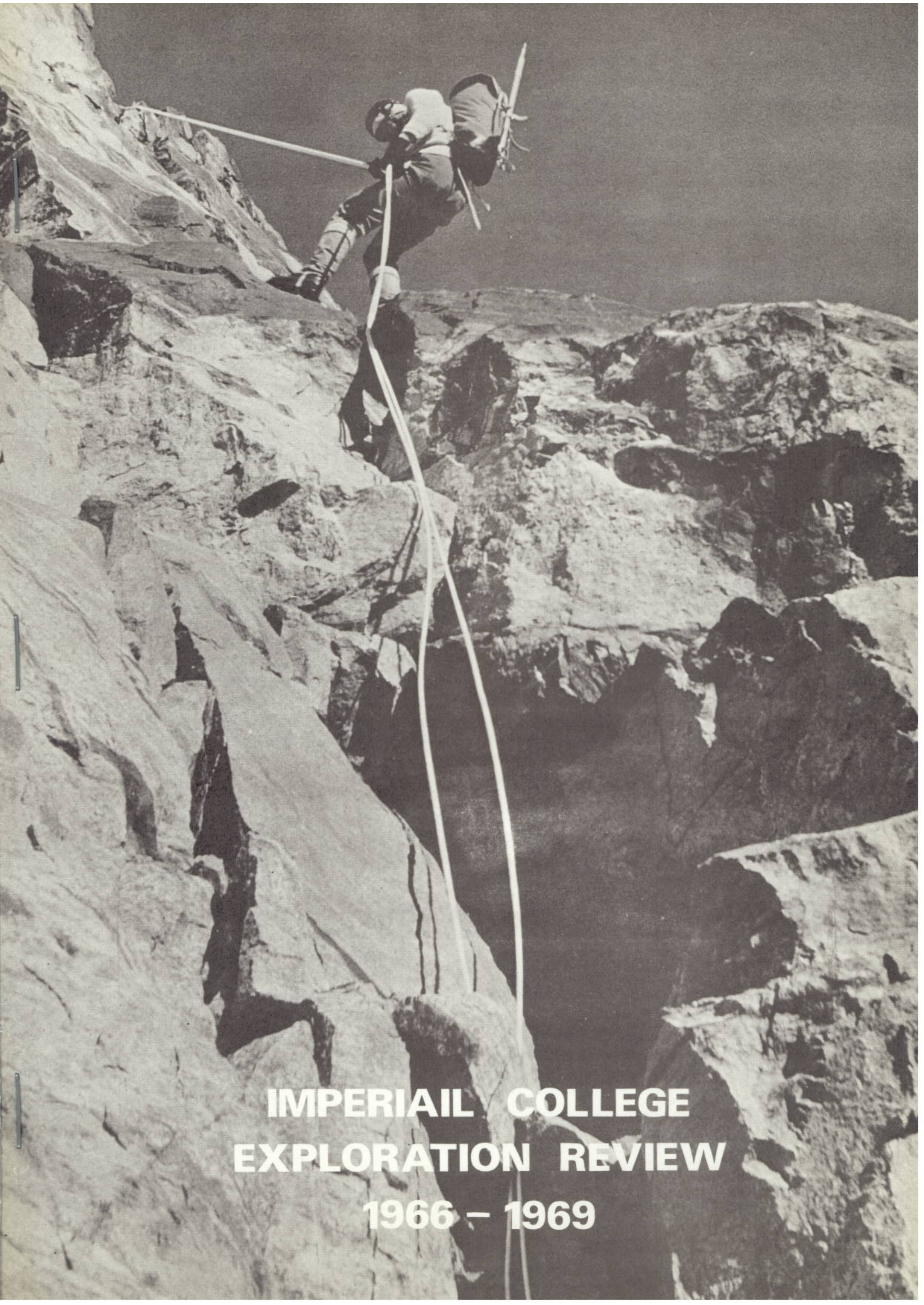


IMPERIAL COLLEGE EXPLORATION REVIEW 1966 – 1969

FOREWORD

The Imperial College Exploration Review was last published in 1966 and included accounts of the 1965 Imperial College Expeditions. The present publication is intended to bring up to date the printed record of Imperial College Expeditions that have taken place in the years 1966, 1967, 1968, and 1969. I am very grateful to Richard Beck for asssembling most of this material and for writing the editorial. The latter in some ways seems to contradict the optimism expressed in the editorial of 1966, but it is well known that student habits change from year to year, and although there appears to have been a slackening off in the student Exploration Society's activities as one of the College Clubs, there is no doubt that the spirit of wanting to go somewhere and do something on one's own in a country where one is entirely self-dependent, is very prevalent still as is shown by the number of expeditions that took place from 1966 to 1969.

There is no doubt that illustrated lectures about other College expeditions inspire the enthusiasm of those students contemplating such adventures and the Exploration Society would do well to encourage these lectures. In arranging such meetings and subsequently in maintaining any useful contacts made, members of an Exploration Society can do a lot to help themselves and at the same time provide informative entertainment for those who are keen but unable actually to take part in expeditions.

In addition to this, there are many functions which members of an active Society can carry out such as organising food supplies, medical and general equipment, etc. Continuity of experience is a great help here and I sincerely hope that the Exploration Society will continue in existence and grow in strength.

A. STEPHENSON
Chairman
Imperial College Exploration Board

EDITORIAL

During the three years since the last Exploration Review, expeditions with the support of the Imperial College Exploration Board have set forth in unreduced numbers. But the same enthusiasm and support has not been directed towards the Exploration Society. The aim of the Imperial College Exploration Society has never been to organise expeditions, but to bring forth ideas for expeditions, to give assistance to those people organising expeditions and to produce a review of these activities, to do which it needs not only the advice but active help of those people that have been on expeditions. Latterly this has not been the case and it was even suggested by some students that such a Society played no useful part in the context of modern life. The main reason produced was that travel to nearly all parts of the world had become so cheap because of student travel associations that expeditions were not needed. Fortunately, this cannot be the case since the number of actual expeditions has not been reduced. These expeditions usually had a scientific background, since Imperial College is basically a scientific College and they all, on the whole, have required a great deal of planning and entailed some sacrifice by the individuals involved.

Occasionally, expeditions have been refused support by the Exploration Board and this has caused some misunderstandings as to what is a suitable expedition. To illustrate this, one can look at the expeditions reported in this review. Two of what might be termed "marginal" expeditions that received support were the 1966 Expedition to Nigeria and the 1968 Sierra Leone Expedition. In these cases the areas visited were not "off the beaten track" and the project was partly organised by people in the countries involved or by Industry. These may be regarded as approaching the field of organised vacation work as opposed to expeditions. An example of the type of expedition fully meriting the support of the Board is the 1966 Minas de Lipez Expedition described in the review.

Since the Exploration Society has not functioned recently the annual review has not bee published. However, this is not the prime reason for a change of production. The main reason is that the high cost involved in producing the review by offset printing could not be met due to lack of sales. Nevertheless, it was thought that a review was necessary to maintain a record of the expeditions from Imperial College and to show the nature and success of these expeditions, full accounts of which are recorded in the Expedition Final Reports which are available in the College libraries and elsewhere.

This year an expedition is going to Iceland organised by 1st Year geologists, and it is hoped that this enthusiasm on the part of four freshmen is a good omen for the future and one hopes to see an ever-increasing number of expeditions from Imperial College encouraged and supported by the Exploration Society.

RICHARD BECK
Summer 1968

C O N T E N T S

Reports of Imperial College Expeditions in the following order:

1966 MINAS DE LIPEZ (BOLIVIA) EXPEDITION

Introduction

The expedition was a success in that we completed our projects in the field and at the same time enjoyed ourselves.

Our departure was delayed for about a month by the seamen's strike and it was not until 12th July that we set off from Liverpool in the Lobitos oil tanker, "El Lobo". Three weeks later we arrived at Talara in Northern Peru. Here we split up, two of us going on ahead to La Paz by bus, train, and steamer, whilst the others followed slowly behind in the heavily laden Land Rover.

In La Paz, we were well received by the Bolivian Ministry of Mines and Geobol (Servicio Geologico de Bolivia). Geobol provided us with all the known geological data on Lipez and assigned two of their most proficient geologists to assist us for part of our time in the field. When the Land Rover arrived in La Paz, we continued on the two-day journey to Uyuni. From Uyuni, we drove 100 miles south to the town of San Antonio de Lipez, 15,200 ft.

The town was completely deserted save for the old man and his wife who cared for the large thatch-roofed cathedral, which dominated the mud huts around it. We stayed at San Antonio for about 3 - 4 weeks studying the mines in the vicinity, and in particular, the Mesa de Plata mine. Although the sun was very warm, the wind at times was bitterly cold and we were glad for the shelter of the mudhouse where we lived, and for the warm clothes and sleeping bags we had brought with us.

After a busy time at San Antonio, we moved down to San Pablo, 14,200 ft., to be nearer the Buena Vista and San Juan mines. The village was populated mainly by children, as their parents had gone away to work in Argentina. The people here were starving and certainly did not have anything like a balanced diet. Black maize and llama meat were their only means to keep out the cold, hunger and disease. We gave them what food we could, and their kindness in return we shall never forget.

With mixed feeling we left San Pablo for Uyuni and then over the mountain road to the ancient city of Potosi. Here, we visited the oldest working mine in the world, carved inside Potosi's hollow mountain, the Cerro Nico. After our stay in Potosi we continued to La Paz via the splendid capital city of Sucre and the busy towns of Cochabamba and Santa Cruz.

In La Paz we came up against the Bolivian administration when we tried to sell our Land Rover. Eventually, we gave up and made our way quickly to Lima, where we shipped the Land Rover back to London. Our return journey was by air from Lima to Miami, and then by Greyhound Bus up the Eastern Coast of the United States to New York. Our travels were completed in London after flying across the Atlantic by Icelandic Airways.

Mining Report

It is reported that 200 years ago San Antonio de Lipez had a population of 15,000. There must have been a very large and rich mine to attract so many people to live in such a desolate place and it was with surprise that we discovered the mines in the immediate vicinity of the town proved to be recent prospecting adits, which had failed to reveal ore.

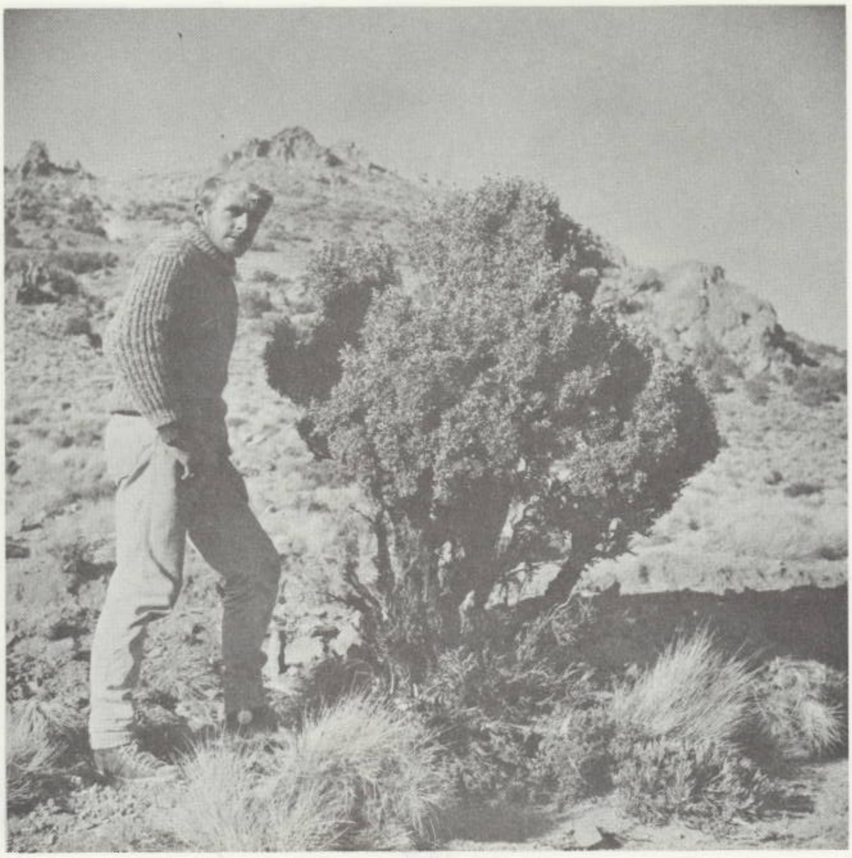
However, two miles to the East of the town we came across the large Spanish mine, "Mesa de Plata". It was here we first saw the beautiful arched adits characteristic of Spanish mines and the rich galene-sphalerite veins in which we believe the silver was carried. The high percentage of cadmium in this ore hinted at a possible future for the mines. "Mesa de Plata" provided us with an accurate picture of a large Spanish mine and we spent some time in and around the mine investigating the techniques used in the mining. Mining took place on several levels and many of the small adits seen near to San Antonio were found to be main ways to the main mine, with the ore being hauled along the main adit. The large spoil heap just outside the entrance was sampled in random positions to assess the mineral wealth left behind. The buildings were definitely of two generations, one Spanish and the other very recent. There were sufficient buildings to accommodate about 200 men and in addition a store and an animal yard were identified. We failed to find any trace of a smelter here.

Nearly all the other mines around San Antonio proved either to be inaccessible or too dangerous to investigate.

San Pablo proved to be a more interesting area. Our attention was centred on three Spanish mines, Leoplan, Buena Vista and San Juan. Leoplan is now being worked by a co-operative, who exploit an extremely rich antimonite vein. The other two mines were not being worked, but are owned by the same concern. Buena Vista followed a dominantly galena vein with accessory sphalerite, antimonite and pyrite, and had been worked in a similar but smaller way as "Mesa de Plata". Our examination of the San Juan mine revealed a very rich galena-sphalerite vein, which must make the mine a sound economic proposition. The large spoil heaps in the vicinity were sampled, but little is expected from these results. Grinding and smelting equipment and a system of drainage channels were also observed and recorded with the aid of drawings and photographs.

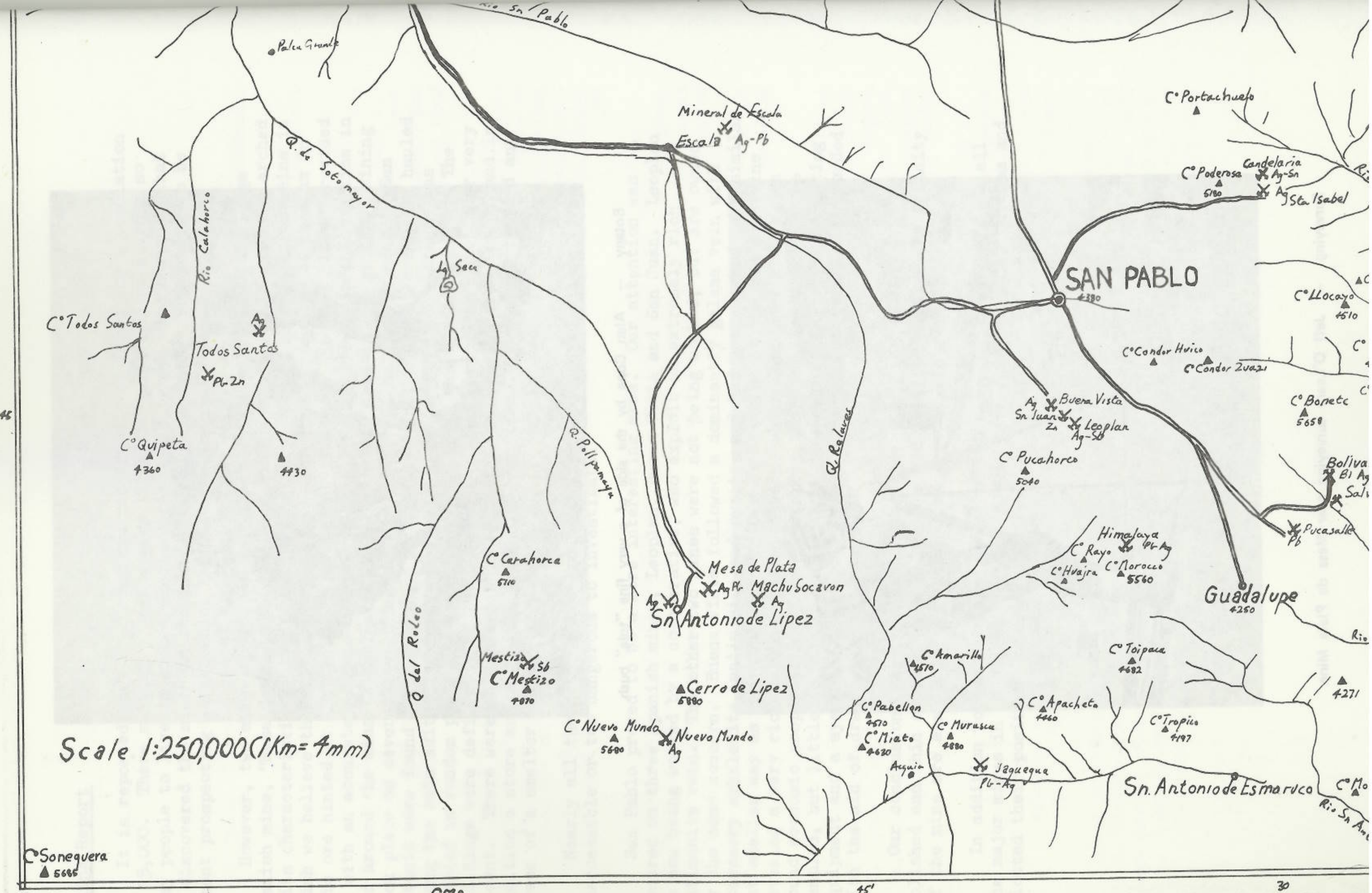
Our conclusions regarding the closure of the mines, details of polished and thin section work on the ore and detailed maps in the vicinity of the mine are available in our final report.

In addition to our detailed survey of the mines we tried to visit all the major mines in the Lipez region, and we have recorded notes on them and plotted their positions on a map.



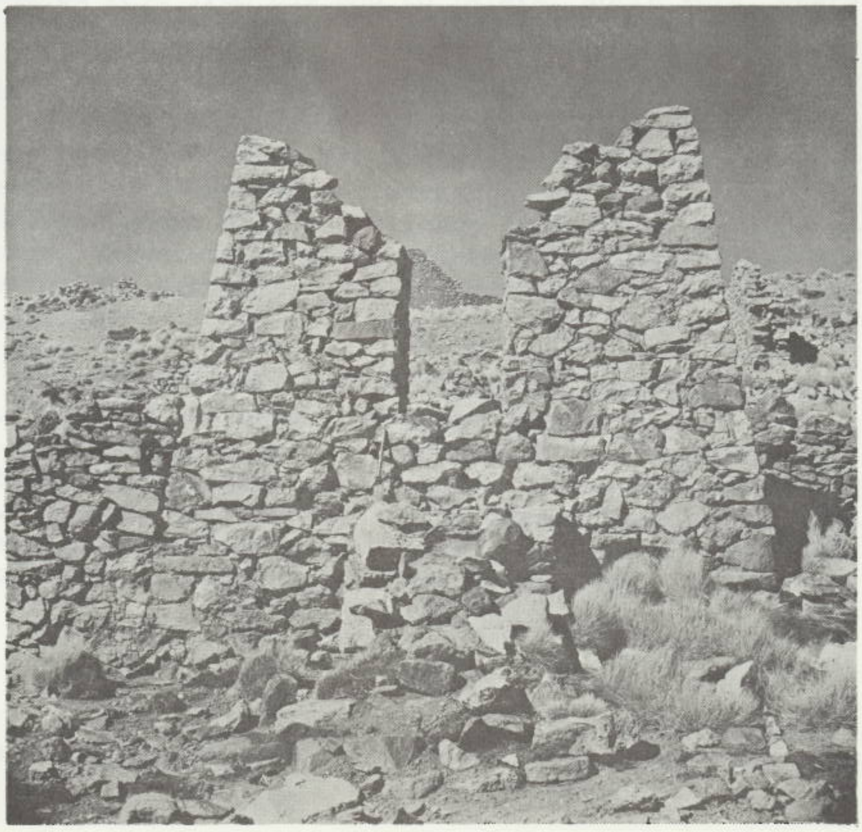
Botany — Alan Cope by the side of a very fine "tola" bush.

Surveying — Jeff O'Leary surveying near Mesa de Plata Mine.



Rio Sn Pablo
Palca Grande
Mineral de Escala
Escala Ag-Pb
Q. de Sotomayor
Rio Calahorco
C° Portachuelo
C° Poderosa
5180
Candelaria
Ag-Sn
Ag
Sta Isabel
SAN PABLO
4380
C° Llocayo
4510
C° Todos Santos
Todos Santos
Pb-Zn
La Seca
C° Condor Huico
C° Condor Zuazi
C° Bonete
5658
Buena Vista
Sn Juan
Zn
Leoplan
Ag-Sb
C° Quipeta
4360
4430
Q. Pollpamayu
Q. Ralaves
C° Pucahorco
5040
Bolivar
Pucasalle
Pb
Himalaya
Pb-Ag
C° Rayo
C° Huajra
C° Morocco
5560
C° Carahorca
5110
Mesa de Plata
Ag-Pb
Machu Socavon
Ag
Sn Antonio de Lipez
Guadalupe
4250
Q del Roteo
Mestizo
Sb
C° Mestizo
4870
Cerro de Lipez
5880
C° Amarillo
4510
C° Toipaca
4682
4271
C° Pabellon
4510
C° Miato
4630
C° Apacheta
4460
C° Tropico
4197
C° Murusca
4880
C° Nuevo Mundo
5680
Nuevo Mundo
Ag
Scale 1:250,000 (1Km = 4mm)
Acquia
Jaquegua
Pb-Ag
Sn Antonio de Esmaruco
Rio Sn Antonio
C° Sonequera
5686
15'
67°
45'
30
45

San Juan Mine (lower left). Note the subhorizontal stratification in the mountains and the top-heaps in front of the mine.



The ruined smelter, San Antonio de Lipz. The small shovel in the foreground gives scale.

Subsidiary Projects

The altitude and the extreme climatic conditions permitted only the hardiest of plants to exist. Nevertheless, 39 species of plants were collected, recorded and pressed and are at present being identified at the Royal Botanic Gardens, Kew. The plants at 15,200 ft. ranged from a 12 ft. high tree to very fine rockery plants.

Although no useful climatic data was to be expected from our short stay in Lipez, our daily weather readings did give us some idea of the climate. We were at San Antonio at the end of their winter and predictably it did not rain during our stay. Nearly every day we were treated with beautiful clear blue skies and warm sunshine. The maximum shade temperature we recorded was 15°C. The daytime humidity was usually less than 5 per cent and the wind variable in speed and consistent in its freezing temperature.

Perhaps the most useful of the subsidiary projects was our study of the solar radiation at different angles of elevation, using a Volz Actinometer. The clear skies and dry atmosphere were particularly suited to this investigation. Series of readings were taken at San Antonio and San Pablo. Whereas the readings at San Antonio were extremely consistent, those at San Pablo were most irregular and it is hoped that the analysis of the results will provide us with an explanation.

Vehicle Report

We purchased a 1962 model long-wheel base petrol-driven Land Rover for £550 and adapted it for use on the road conditions expected at a further specially reduced rate from England to Talara, North Peru, where we collected it.

While in South America, we covered over six thousand miles, only one thousand of which was on tarmac roads. The vehicle performed very well, the only breakdown being caused by the disintegration of the starter motor and one was made for us in the railway workshops in Uyuni. The vehicle was heavily loaded for about half the mileage to near the maximum recommended for rough roads. However, despite the heavy loading and the markedly reduced power at the high altitudes, we were never in any danger of stalling on the steep hills.

It was intended to sell the Land Rover in Bolivia, where they are in high demand. However, although there was no shortage of prospective purchasers, the procedures involved in paying the various taxes required for the importation, registration and transfer of the vehicle proved to be too complicated. After six full frustrating days of negotiations we decided to cut our losses and bring the vehicle back to England. We drove the vehicle to Lima, from where it was shipped back to England.

References:
Expedition's Final Report

The above account is based on the Expedition's Preliminary Report.

1966 EAST GREENLAND EXPEDITION

During the summer of 1966 an eight-man expedition from Imperial College worked in the Mount Forel district of East Greenland. As this region is 70 miles from the nearest accessible point on the coast, the bulk of the equipment and food was air-dropped into the area. The members of the expedition marched in from the coast, a journey taking about eight days. During the march, the leader fell and broke his ankle whilst on skis and had to be left with one companion at Conniats Bjoerg- about half-way in. The ankle was set by the doctor of another expedition in the area (Royal Navy) and after five weeks in plaster had healed sufficiently to march on out.

The accident caused a considerable disruption to the expedition. It had been planned to drop the loads to a ground party who would prevent them blowing down the glacier. Although the ground party had not arrived, the loads were dropped blind, and were consequently blown down crevasses. Recovery of the loads was not difficult but took considerable time.

Despite this, members of the expedition climbed a total of sixteen peaks. Of these, seven major peaks of about 2,900 m. along the Paris Glacier and included Pte, du Harpon, Table Mountain and de Quervain's Bjoerg. These mountains usually gave 5,000 ft. climbs from the main glacier followed by a fairly loose rock ridge.

The main feature of the climbs from the Paris Glacier proved to be the time taken - none of the routes took less than 14 hours and two 25-hour ascents were made. Eventually, one bivouac became normal and many classic Alpine 'difficile' routes were done. Several of the peaks, notably de Quervain's Bjoerg and Serac peak required some difficult rock climbing on their ascents.

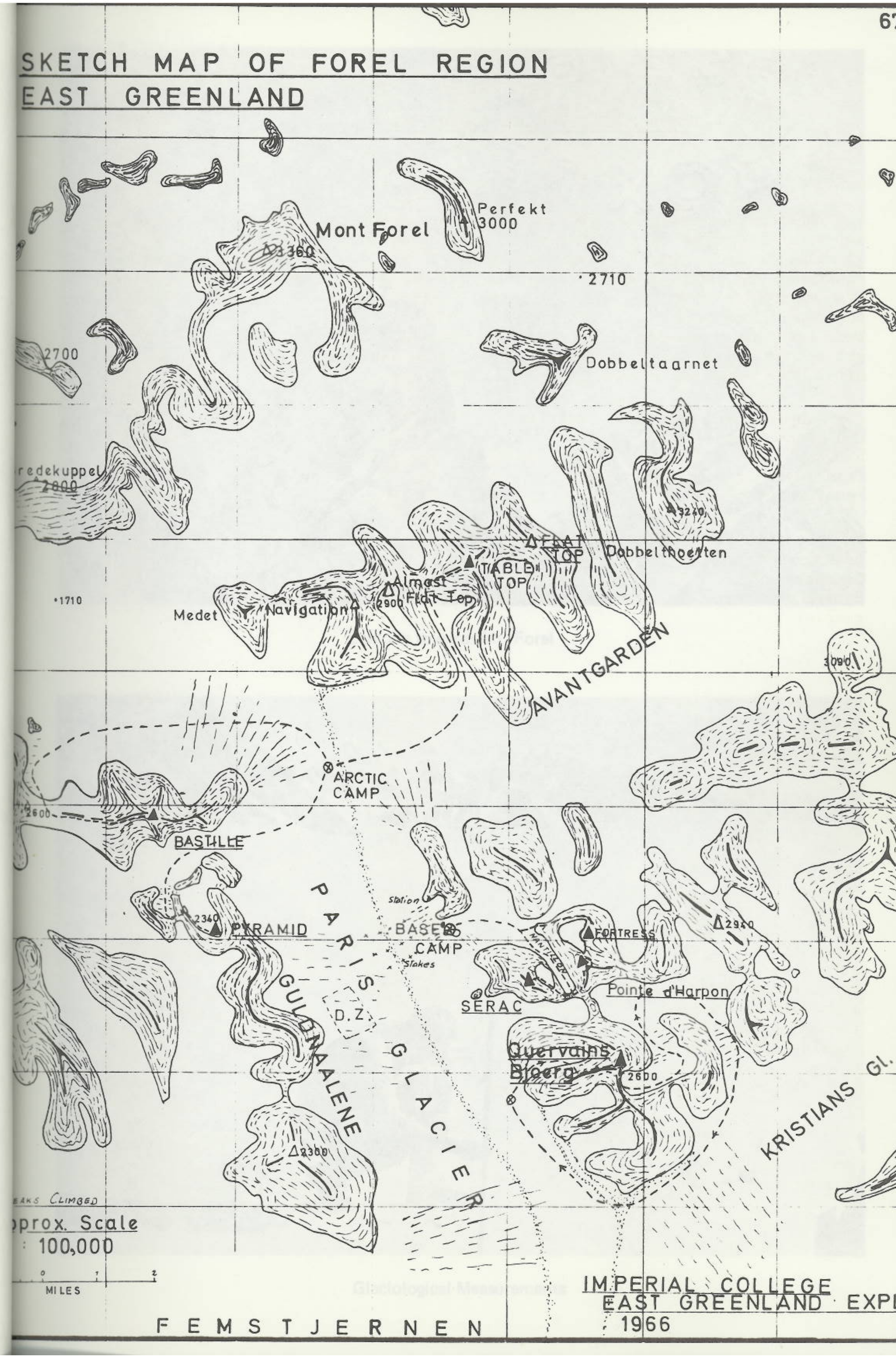
The other nine peaks were climbed near the Conniats Bjoerg - six by J.R. Taylor in conjunction with the Royal Navy expedition.

A glaciological programme designed to explore the possibilities of the measurement of ice depth by electrical resistivity techniques was also carried out. By measuring the resistance between pairs of electrodes of various separations the resistance of the ice at various depths can be found. At the glacier bed there is a discontinuity in the electrical conductivity as the ice changes to rock and this appears as a deviation in a plot of the electrode resistance against separation from that predicted. Results obtained in this manner were compared with values obtained by measuring the surface flow speed of the glacier. It was however, found that the prime cause of the variations was due to the surface layers of ice, which considerably confused the experiment.

The cost of the expedition amounted to about £2,700.

References:
Expedition's Final Report

From the Expedition's
Preliminary Report.


SKETCH MAP OF FOREL REGION
EAST GREENLAND
Mont Forel
3360
Perfekt
3000
2710
2700
Dobbeltaarnet
redekuppel
2000
3240
FLAT TOP
Dobbelthoetten
TABLE TOP
Almost Flat Top
2900
Navigation
Medet
1710
AVANTGARDEN
3090
ARCTIC CAMP
2600
BASTILLE
PARIS GLACIER
Station
BASE CAMP
Stakes
2340
PYRAMID
FORTRESS
2940
SERAC
Pointe d'Harpon
GULDNAALENE
D.Z.
Quervains Bjoerg
2600
KRISTIANS GL.
2300
EAKS CLIMBED
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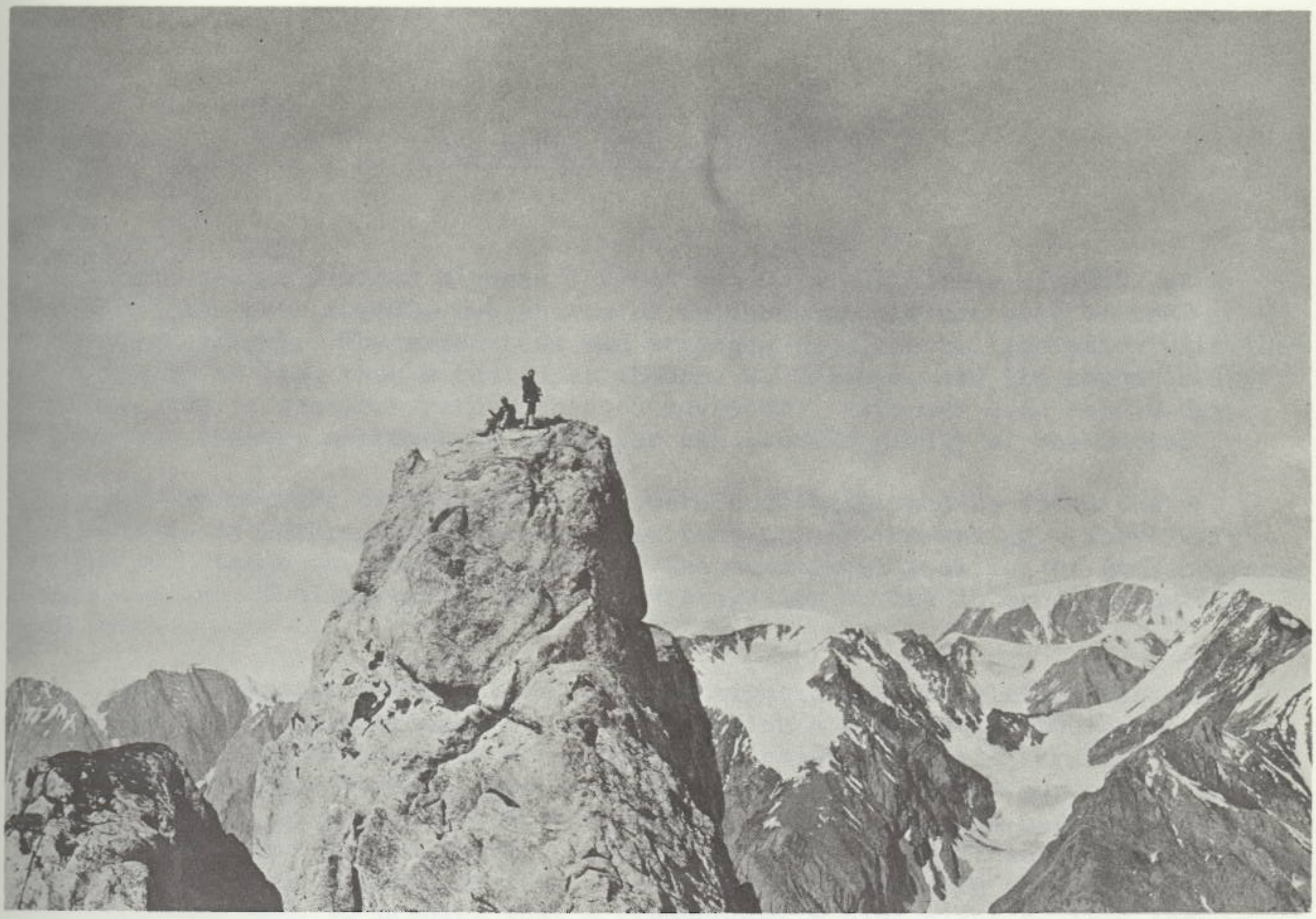

Looking towards Mt. Forel

Glaciological Measurements

1966 EXPEDITION TO NIGERIA

Seven people visited Nigeria for ten weeks in the summer of 1966, at a cost of just over £1,000, two thirds of which comprised the cost of the chartered flight. The expedition was arranged in close collaboration with the University of Ife, then situated at Ibadan, W. Nigeria, and the emphasis lay on the side of research rather than on adventure, although even day-to-day life in a country approaching civil war can provide plenty of the latter.

All the members of the expedition were zoologists and we found the experience of working in a tropical environment very rewarding. There were three main projects, namely a study of the ecological position of grasshoppers, a collection of slime-moulds and an investigation of the internal parasites of bats.

The grasshopper project involved investigations of population density (for comparison with British studies), in which a marking-recapture technique was used, the marking medium being different colours of nail varnish. In the area of grassland studied, there were about 2-3 grasshoppers per square metre. By dissection, we were able to determine the chief parasites and also the food preferences of some thirty species. We found it possible to distinguish between different species of food plant from the remains in the insects' crops. We were also able to predict what a grasshopper's diet might be from the structure of its mandibles. In grass-feeding species, the mandibles are ridged like the teeth of sheep; in those feeding off softer plants they become cusps like the teeth of pigs.

The myxomycete collection has added materially to the knowledge of the Nigerian Species. Curiously enough, more than half the species from Nigeria are also known in Britain. About a dozen species new to Nigeria were found, and of these three were new to the continent of Africa.

In the study of bat parasites, 115 specimens of three different species were dissected. They were caught in mist nets placed across the flight-paths of their roosts. A blood smear was prepared from each bat, which was then killed and smears were made of the heart, lung, liver, pancreas, spleen, kidney and brain. The urinary and gall bladder and the whole of the gut were examined for parasitic worms. The bats were remarkably free of protozoan parasites, but two intestinal flukes, present in some members, proved to be new species. These were described and named in the Journal of Parasitology Volume 54, Number 5, October 1968.

Most of our work was carried out at Ibadan, in the forest zone, but through the generosity of the University, we were able to visit their Field Station 280 miles further North, in the Savannah Belt. We were also able, thanks to the University authorities, to make a six-day tour of the country which enabled us to see something of the wide variety of the Nigerian countryside and its people.

Bill Dolling

References:
Expdition's Final Report
Journal of Parasitology, Vol. 54, No. 5, October 1968, Pages 935 - 938.

1966 EXPEDITION TO MALTA

If the conquest of the oceans is to continue man must be able to communicate underwater. An undersea cave provides a unique possibility of examining a sample of water which is cut off from the rest of the sea. It was in order to study these two topics that a party of six students set out for the clear tideless waters of Malta in the summer of 1966.

Somewhat more than a ton of diving equipment, scientific apparatus and personal clothing was transported through France, Switzerland, and Italy in a 15 cwt. van bought by the expedition. This 1965 vehicle travelled over 5,000 miles on the expedition and the only minor incident was when a radiator hose split whilst climbing the Simplon Pass. A nearby stream saved us from the embarrassment of having to use "you know whose" ginger ale for the radiator. The three members who travelled with the van covered the 1,500 miles from London to Syracuse in five days. It can be imagined how we felt when we were told that the vehicle was too tall to drive onto the boat. However, after parting with a £7 surcharge and standing by ready to let the tyres down if necessary, we drove onto the ferry with a full two inches to spare.

On the island, we met the rest of the party who had flown to Malta by air. We moved into our third-floor flat in Sleima which was to be our base and laboratory for the next seven weeks. Plywood was purchased locally to construct two large workbenches - one housing the chemical apparatus and the other, the electronics. The latter included such items as a signal generator, oscilloscope and dozens of spare transistors, all of which were to prove invaluable.

During the first week, we looked for suitable diving sites, acclimatised ourselves to the cloudless sky, and established our working routine. One diver and a helper would be off before breakfast to fill our 14 air cylinders. Unfortunately, this could take anything up to four hours and we much regretted not having our own compressor. Most of the diving was done by daylight and we returned for an evening meal at dusk. While those of us who were less mechanically minded prepared the meal, the equipment was serviced for the following day's work.

On one particularly hectic evening, August 4th, the log read as follows:-

"One amplifier unstable in the hot sun - investigated and design changed. Underwater loudspeaker (U.S.A. one) leaked - repaired. Oxygen meter gave suspicious readings - checked, major fault rectified and recalibrated. Aqualung stiff to breathe from - serviced."

It was seldom that the evening's work was completed before midnight and on this particular night, a serious fault was found in the oxygen meter which was finally repaired at 3 a.m. This routine of diving in the day and working on the equipment in the evening filled 40 of our 46 days on the island.

It was during the few days when the weather was not suitable for diving that we were fortunate enough to be introduced to the organisers of the "Lia Festa". The festa is a three day event in honour of the village saint. The climax takes place when a statue of the saint is paraded through the streets. During this period, it is important that the devil is kept at bay, and this is accomplished by means of "fireworks". The inverted comas are intentional as it is important not to confuse these fireworks with the type sold in this country for November 5th. During the two hours that the statue is out of the church, around 2,000 mortars are touched off. The largest of these weighs anything up to 25 lbs. and is launched from a sawn-off gas cylinder. The intensity of this barrage must be unique outside military training grounds. These fireworks are made by local volunteers, and are the result of 12 months part-time work. Unfortunately, some villages use explosives removed from wartime bombs and there are fatalities on the island most years. As the last echoes died away at around 11 p.m., the hospitality shown to us by these pyrotechnicians in the local bars was no less impressive.

Most of our diving was from Marfa point, the northernmost tip of the island. Here there was a little-used concrete quay which proved an ideal place to unload the equipment within a few feet of the water. The most unpopular job on arrival at Marfa was to inflate the rubber boat. During the first two weeks, we were able to use as much compressed air as we wished and some could generally be spared for inflating the boat. Later, the position changed, and the boat had to be hand inflated all the time. All equipment was removed from the van which was turned into a chemistry laboratory for sea water analysis. The tape recorders and amplifiers were set up on wooden boxes on the quay along with two large car batteries and a mains voltage inverter for providing the necessary power. The communication experiments were performed in the relatively shallow water near the quay. One particular communication set involved the diver wearing a mask that covered the whole of the face and a type of crash helmet complete with a small antenna on the top. One can well imagine the effect that seeing a head appear above the water had on the local fishermen. At first they thought that this would scare the fish away and were hostile towards us. We resorted to the ruse of suggesting that ultra sound attracted fish. However, we were no better off. Regardless of the effect of ultra sound on fish, we have proof that it attracted fishermen!

The depth of water at the quay was nearly 20 feet and the rocky bottom shelved gently down to a sandy plain at 60 feet. Four hundred yards along the shore were a suitable collection of caves in about 60 feet at the bottom of an impressive underwater cliff. Apart from countless shoals of small fry and the occasional playful octopus or sting ray, the area was barren of large fish. The abundant sea urchins took their toll of personnel and although very little time was lost whilst out in Malta, two members had to seek medical advice for urchin wounds when the expedition returned. A rather more unpleasant creature resembled an overgrown caterpillar some 9 inches long. We came into contact with these on two occasions and in each case the victim had to be lifted out of the water. Although helpless and in considerable pain for about an hour, the diver had no mark on his body and apart from an anaesthetic effect which lasted the rest of the day, there were no long term symptoms.

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When we dived in caves, we carried a small hand-held aqualung with us. The idea, which came from one of the "James Bond" films, was put to the test when a breathing valve jammed while in the inner chamber of a deep cave. To reach the surface the diver had to swim horizontally for 60 feet to the entrance of the cave and then up some 55 feet to the surface. We were glad that we had practised our safety drills.

One of the results of our scientific programme was that our work with communication equipment was put to use by at least one manufacturer who was able to design a better communicator as a result of our findings. Inside the caves, we found that the temperature of the water increased and the concentration of dissolved oxygen decreased. Over 30 photographs of the area around the caves have been pieced together to form a mosaic.

During our stay, we made many friends on the island who were most generous with their help and hospitality. The journey back by road was completed in three days. After our return, most of the team took at least a week's rest to recover from the rigours of the expeditions.

Because of our sudden change of location, we had no time to make a study of the literature of the area, so we modified our work accordingly. A collection of the skins and skeletons of forty species of birds was made, and during this work a large amount of new information on Mallophaga was obtained. Collections were made of Lepidoptera, reptiles, freshwater fish parasites, freshwater snails and Tipulids. New data on the Guyanese avian fauna, reptile parasites and ants was also recorded.

For water transport we used two Chrysler outboard motors to propel our own rubber boat and a local wooden canoe. On one occasion we hired an Amerindian guide to take us up the rapids to hunt caimen. This was, in retrospect, a hair-raising experience.

The five of us, with camping gear for four days, set off in the canoe. When we reached the rapids, we witnessed the skill of our guide. The river was half-way between rainy season and dry season levels, and was running very fast. At some places we had to disembark and push the boat up the side of rapids, waist deep in water in which we had caught pirahna. At other places two of us and half the gear were left on a suitable rock in the middle of the torrent, while the others were taken by the guide to another rock upstream before he returned and repeated the operation. It took a day to pass the rapids. We camped above the rapids on an island, and went out at night with a strong torch, which when shone along the water level was reflected by the alligators eyes. In the dark, and with the strong currents, trying to shoot a caiman was not easy.

On one occasion the guide would not let us shoot, beqause he said judging from the distance between the two red dots he could tell that the animal was large enough to turn the boat over it it was only wounded.

Eventually, we shot a six foot specimen, which took hours to skin because caimen have bony plates embedded in the sub-epidermis. On the return journey, some of the rapids were shot in great style, but others had to be tackled by the same methods as used on our way upriver.

We encountered little trouble on our return journey, spending a day on Trinidad again, then driving a Lincoln Continental to New York, via Expo'67. After two days in New York without money, we caught the return B.U.N.A.C. flight to London.

References:
Expedition's Final Report.

ETHIOPIA 1967

The Imperial College Ethiopia 1967 Expedition had two main objectives:-

(a) A study of the airways of Ethiopia.
(b) The mapping of the geology of an area on the edge of the Great African Rift Valley.

The aeronautical project was executed by C. Satchwell, (leader) and C. French, both aeronautical engineers, with the assistance in the later stages of C. St. John, a mining engineer. The geological project was performed mainly by J. Harris, a geologist, with assistance of T. Marples, metallurgist, and initially C. St. John before he joined the areo party. Mr. Levin Djerahan, although not an official member of the expedition, accompanied the areo section everywhere and proved an invaluable interpreter and guide.

We arrived in Addis Ababa on Monday morning, 17th June. On Tuesday, St. John and Marples went on a three-day field trip with Dr. Gibson of the Geology Department, University of Addis Ababa, to investigate a small volcano, Mt. Chabbi. The others, while in Addis Ababa were cutting red tape, obtaining permission to do this and that for the geological party and getting aerial photographs of the area to be mapped. By the end of the first week, most of this had been done and we set off on our various projects.

Aeronautical Project

In all 36 airfields,were visited and surveyed. Also, details of passenger and freight traffic were recorded for that year, 1965 and 1966. The air routes can be divided into four regions :- Southern, Northern, Western and Red Sea.

Southern Region services thrive bacause of poor surface communications and the natural wealth of the countryside. When new roads are completed from Ababa to Goba and from Goba to Ghinner, much of the present traffic will vanish, but it is more than likely that new airstrips, located near isolated towns will continue to support an airline service. The present internal security operations in the area have two effects on the airline. The first is to provide more traffic, both passenger and freight, as government officials and rifles are flown to Army garrisons. The second, is to inhibit economic development of the area and lose the traffic which would have been generated by this development. When the military do withdraw, the airline should profit until the withdrawal has been completed, when a slack period should set in, until the region develops.

The only all-weather road in the region connects Shashmene with Ababa, and thereafter, a seasonal road exists as far as Goba, and a trail, which frequently vanishes into scrub, goes on to Ghinner. All other roads marked on maps are either fiction or else open scrub which some vehicles can drive over. Beyond Ababa, the only vehicles seen are either four-wheel drive trucks or Land Rovers. A new road is being constructed, which will connect Ababa, Goba and Ghinner.

Western Region

The Western region has very fertile soil, which will grow almost any crop, and is Ethiopia's principal unexploited asset. Few roads exist in the region, and those that do just connect the provincial capitals with Addis Ababa. New roads are being constructed at present between Toppi, Mizan, Toferi, and Jimma, Agaro and Buno Bedelle and Nekempt and Ghimbi. When these roads are completed, the lucrative freight traffic between Mizan, Toferi, Toppi and Jimma will be lost. No new road to Gore has yet been planned, nor to any of the towns beyond.

Few Shiftas roan the region, although there are reports of Slave trading on the Sudan Border.

Northern Region

Most of the North-bound traffic goes to Asmara, by EAL's jet flights. The rest go by DC 3 or C 47 to the small stations en-route.

Good roads, and abundant bus services exist between all the stations en-route, with the exception of Mota and Lalibella. A new road is being constructed to Lalibella but this is unlikely to affect airline passenger traffic, as most passengers are tourists without motor cars. Freight traffic will be affected. Operations to Lalibella cease during the rainy months of July, August and September. Mota is supplied entirely by air during the rainy season due to the absence of any all-weather road to the town. There is no prospects of any new road being built to Mota, and so its airline service seems to have a sound future.

Red Sea Region

Red Sea regional services are linked with international flights to Djibouti, Aden and Taiz. In the schedules shown above, most of these aircraft call at some foreign destination before or after internal stops.

Prospects for traffic expansion are good, as the war in the Yemen now seems likely to end, and the Imperial Ethiopian Government is putting money into the port of Assab. A new, and better international airport is planned for Assab, which might be included in the next five-year plan. Also a new road to Assab is planned, which, when completed, should make Ethiopia independent of the port of Djibouti in French Somaliland.

Roads in the region are good by Ethiopian standards, and even the dry weather trail between Assab and Massawa is passable for most of the year, although it vanishes into open scrub in places. Between Massawa and Asmara, there is both a road and a railway. The distance is 115 km. and the train takes about 4 hours to steam up the hill to Asmara. The bus takes even longer. Massawa handles all the imports and exports of the Northern region and at present it is probably the largest port in the Empire. It is also an attractive holiday resort and attracts tourists from all over the world.

Geological Project

On the advice of Dr. I.L. Gibson and Dr. W. Padgam of the Geology Department, Haile Sellassie II University, Addis Ababa, an area to the South of Dira Dawa was selected for geological investigation.

Dira Dawa lies in the province of Harrar, E. Ethiopia, about 35 km. North of the provincial capital, Harrar. The town was built by the French at the turn of the century during the construction of the Djibouti-Addis Ababa railway.

Immediately to the South of Dira Dawa, a series of step faults raise the land surface from 1,207 m. at Dira Dawa to 2,500 m. on the plateau land to the South. These faults form the Southern boundary of the Afar Depression which is part of the Great East African Rift system.

The area mapped is one of moderate relief with a series of approximately east-west homoclinal ridges of limestone each with a steep scarp slope facing north and a dip slope facing south. Between the ridges are flat-floored valleys, usually occupied by sandstone. Further south, the underlying basement rocks are brought to the surface and the land rises very steeply up to the Harrar plateau.

Cutting across the strike of the country are a series of dry rivers, (wadis), some of which are very wide and provide convenient routes into the area.

The climate is hot and arid, and the vegetation is restricted to cactus and thorn scrub. Exposure is practically 100 per cent on the limestone ridges, but the valleys are often blanketed by sands and gravels.

The area was mapped by aerial photographs, on a scale of 1:20,000 which were purchased from the Imperial Highway Authority. A total of seven weeks were spent on the project, five weeks in the field, and two weeks seeking official permission to work and to buy the aerial photographs. The work was done on foot from base camp in Dira Dawa.

This area is on particular interest for the following reasons:-

Reconnaissance mapping has shown the presence of a series of small intrusions of a fine grained whitish rock, the form, mode of intrusion and petrology of which were unknown. Rocks of a similar aspect have been found as xenoliths in volcanic rocks to the south-west.

The area has not been mapped in detail before.

Geological History

A basement complex of Precambrian schists and gneisses is overlain by Mesozoic marine sediments. The sediments of the Dira Dawa area are Jurassic. They consist of a lower series of limestones, sometimes seen lying directly on the basement rocks and sometimes separated by thin conglomerates and sandstones; the basal Adigrat sandstones are apparently missing in this area. Above the limestones is a sandstones series.

In the Upper Eocene, Ethiopia was affected by the Arabo-Ethiopian swell, along which the Rift Valley developed.

The sediments of the Dira Dawa area were cut by a series of small intrusions mentioned above, possibly during the phase of rifting. Basaltic dykes and sills were also intruded along faults.

Both projects were successful and we achieved all our aims, but naturally we would have preferred to stay out in the field longer to elaborate upon our findings. A fuller account of the expedition projects and results may be found in the expedition's Final Report.

1967 EXPEDITION TO GREENLAND

The object of the 1967 expedition was to visit the same area as the 1966 expedition and continue the mountaineering and glaciological activities. It was also hoped to recover the parachutes left in the area by the previous expedition and make geological and botanical collections.

As we were unable to have an air-drop of supplies, we had to carry all our equipment into the mountains ourselves and consequently, the original route, taking ten days, was out of the question. Instead, we intended to attempt a new route via the Kangerdlugssuatsiag fiord and the Glacier de France; this would reduce the distance to about 40 miles and also cut out several high passes which had to be negotiated on the old route.

We arrived in Greenland to find that all our food and equipment was stuck 40 miles out in the pack ice on the M.S. Varla Dan. This was a serious set-back as we hoped to get into the mountains as soon as possible to make the most of the fine, but short Greenland summer. The next fortnight was enjoyably spent at the settlement of Kungmiut fishing for cod and salmon in the fiords, and climbing the surrounding mountains in order to get fit. Eventually the Varla Dan ploughed her way in through the pack ice and our equipment was loaded into two 20 ft. Eskimo boats which we had hired for the 50-mile journey up the coast to Kangerdlugssuatsiag.

We sailed through numerous islands, icebergs of every conceivable shape and size, and past the snouts of huge glaciers which were slowly sliding down from the ice cap into the sea. It was indeed a memorable journey. The boatmen deposited us as near as they dared to the snout of the Glacier de France and departed hastily for fear of being swamped by the calving bergs.

Our first base camp was set up by the edge of the Glacier de France and on the first day, the party set out to find a feasible pack-hauling route up the first few miles of badly crevassed glacier. After much zig-zagging between crevasses and retracing our steps, we emerged onto the smoother section of the glacier up which we would be able to haul our gear by sledge. We were feeling very pleased with our day's work as we returned to base camp when an ice bridge collapsed under Geoff Pert causing him to fall 30 ft. into the crevasse below and injure his ankle.

It was decided to continue as planned in the hope that Geoff's ankle would heal, so the other five spent several days pack-hauling the equipment up the glacier to the start of the good sledging. A three-day journey was then made to Coniatsbjerg, the place where the 1966 expedition had left six parachutes, but the parachutes were buried under deep snow and could not be located. A first ascent was also made of a 7,000 ft. rock peak immediately behind the base camp. This was found to be longer and more difficult than expected and over 40 hours were spent on the climb.

The injured ankle did not improve and it was obvious that Geoff would have to return to civilisation in the outboard powered inflatable dinghy, which was purchased for just such an emergency. Geoff and Chris Holt departed for Kungmiut,and meanwhile, the remaining four made the second ascent of Pussugsivit

- a mountain first climbed by a Swiss expedition in 1966. A neighbouring mountain was climbed for the first time together with two other minor peaks. These climbs were all very enjoyable and at times involved fairly difficult and technical rock climbing, but the views of the higher summits further inland made us impatient to start up the glacier.

As soon as Chris returned to base camp, we set off for the interior. The first half-day saw us up the pack-hauling section of the glacier and loading up the sledge. As we were now a man short, the weight on the sledge had to be kept to a minimum. Sledging is, to say the least, very hard work, but one would hardly expect 30 miles of mostly uphill going, with 700 lbs. to drag and crevasses to skirt or cross every few yards, to be a picnic! We also had to contend with "Arctic paddy fields" - large areas of deep wet smow, and melted water streams where one had to stand up to the knees in ice cold water to carry the sledge across. After a day of this treatment, the sledge was beginning to crack up and the skis had to be strapped to it to hold it together.

Fortress - the 1966 base camp - was reached in $3\frac{1}{2}$ days and here we found food left in 1966, still intact - particularly the much-craved chocolate. The 12 stakes which had been drilled into the Paris Glacier in 1966 were still intact and these were re-surveyed to measure the yearly flow of the glacier, the differential flow across the glacier and the ice ablation.

Another half day's sledging took us to within striking distance of the mountains we had come to climb. Up to this time, we had enjoyed the very best of weather, with clear blue skies and long sunny days, but now, when we most needed the good weather, it began to snow.

The snow lasted for two days and was accompanied by very cold winds, making climbing out of the question. In fact, only brief excursions were made out of the tents. On the third day, the sky gradually cleared but the mountains were in no condition for climbing as the new snow was likely to avalanche.

We then had four days of fine weather during which six mountains were climbed, including Greenalnd's third highest (3240 metres). The climbing was very much enjoyed by all although in some cases, the ascents took longer than anticipated and involved bivouacs in the cold Arctic night. Sometimes we climbed on rock, sometimes on ice; consequently the ascents were always varied and interesting.

In between climbs, Graham Swainson made botanical collections from five different nunatakes and some rare and interesting specimens were found. The geological collecting was done throughout the expedition as it simply involved taking rock samples from the buttresses and moraines, and recording their positions.

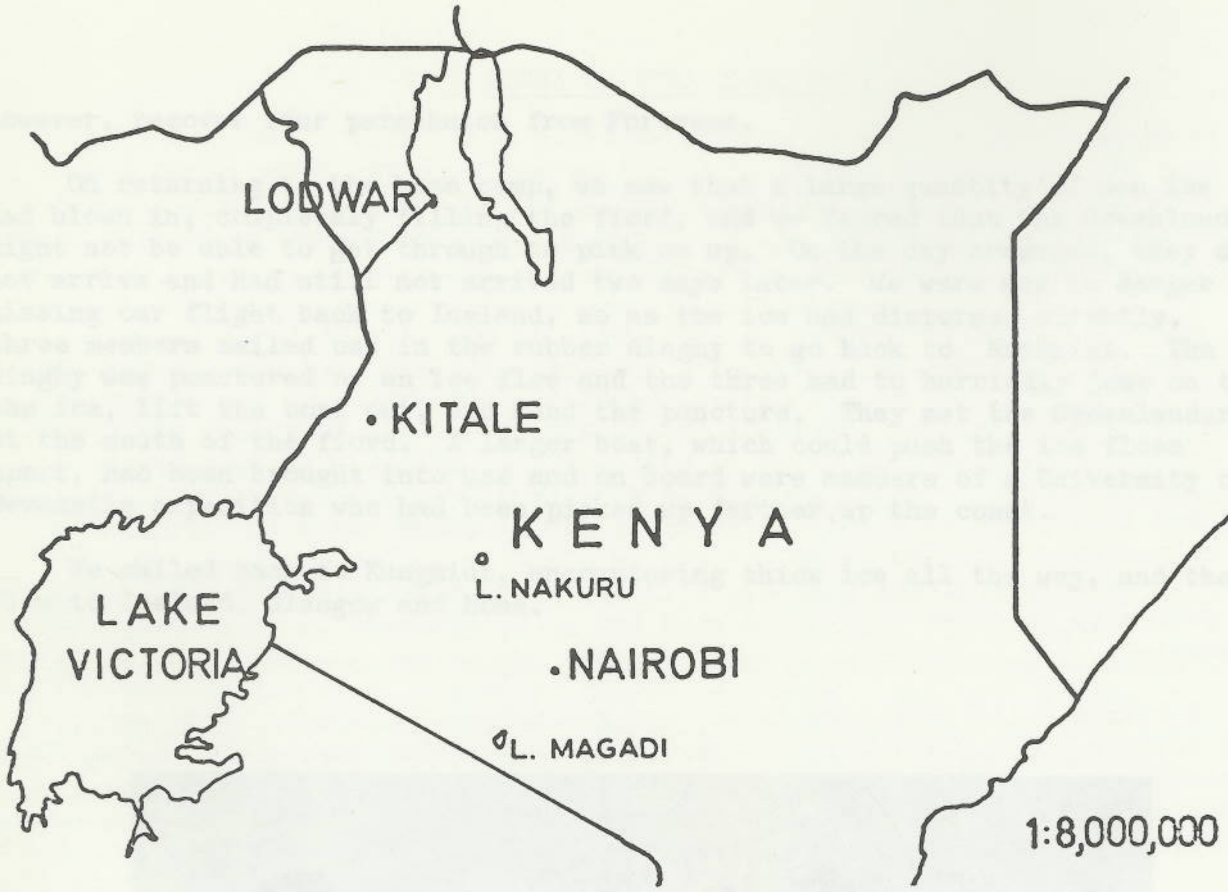
After the four fine days, we were again beset by snow and as our time was running short, we decided to return to base camp. On the return journey, a second visit to Coniatsbjerg was made in the hope that some of the snow would have melted to reveal the parachutes but again they could not be found. We did, however, recover four parachutes from Fortress.

On returning to the base camp, we saw that a large quantity of sea ice had blown in, completely filling the fiord, and we feared that the Greenlanders might not be able to get through to pick us up. On the day arranged, they did not arrive and had still not arrived two days later. We were now in danger of missing our flight back to Iceland, so as the ice had dispersed slightly, three members sailed out in the rubber dinghy to go back to Kungmiut. The dinghy was punctured on an ice floe and the three had to hurriedly jump on to the ice, lift the boat out, and mend the puncture. They met the Greenlanders at the mouth of the fiord. A larger boat, which could push the ice floes apart, had been brought into use and on board were members of a University of Newcastle expedition who had been picked up farther up the coast.

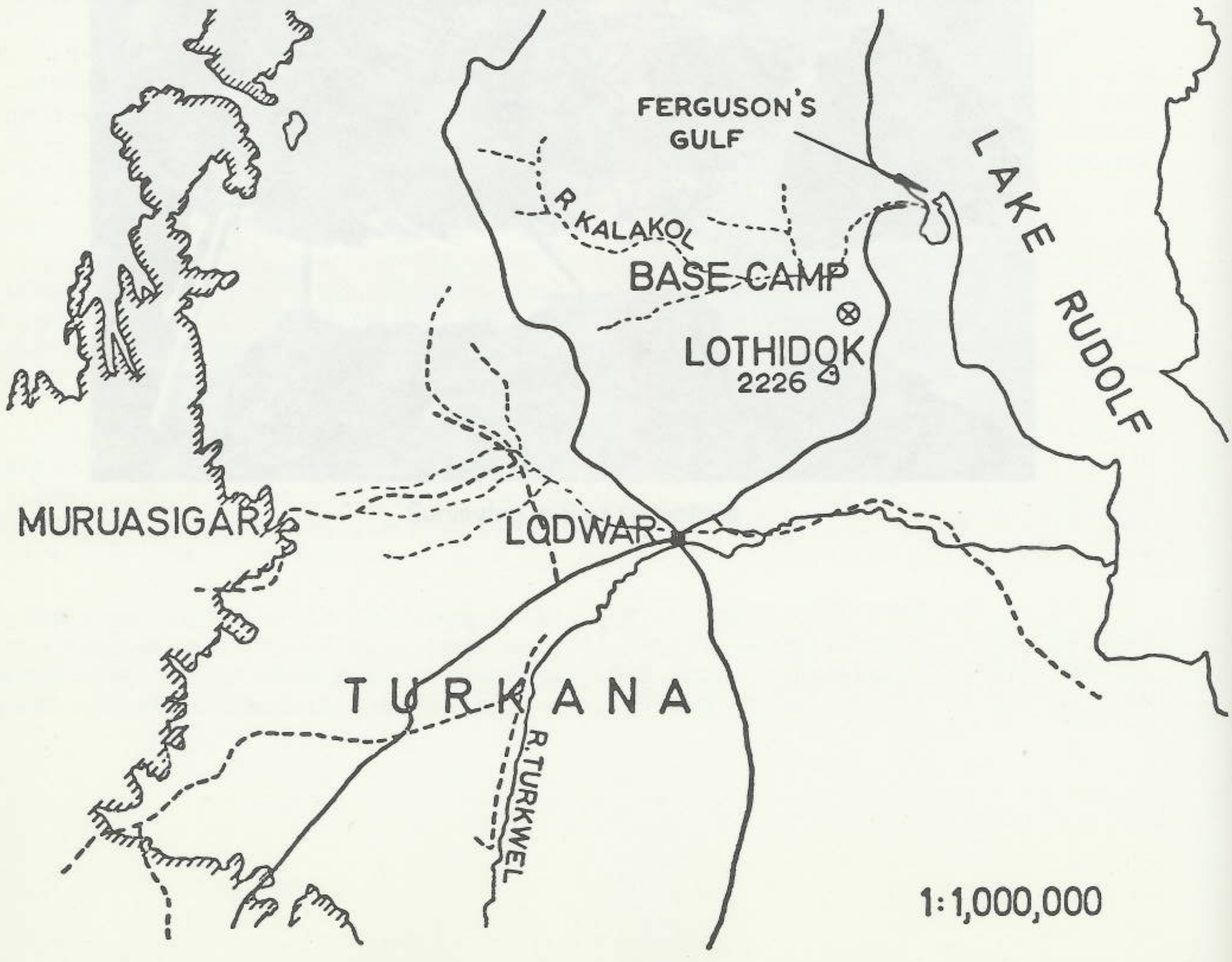
We sailed back to Kungmiut, encountering thick ice all the way, and then flew to Iceland, Glasgow and home.

Surveying in East Greenland

GENERAL MAP. KENYA EXPEDITION 1968



MAP SHOWING SITE OF EXPEDITION BASE IN RELATION TO L. RUDOLPH AND FERGUSON'S GULF



1968 EXPEDITION TO KENYA

Two botanists and three geologists spent the summer working east of Lodwar in the Ferguson's Gulf region of Lake Rudolf. The programme was threefold. First, lake sediments some ten miles inland from present water level were studied and mapped; secondly, the geologists concentrated on mapping ten square miles of volcanic hills near Ferguson's Gulf and thirdly, the botanists made a collection for the herbariums at Kew Gardens and Nairobi.

All three projects planned were carried out and completed successfully, although not as much work was done on the lake sediments as had appeared possible from the aerial photographs.

A total of fifty-eight specimens were collected in duplicate for the Herbarium at Kew Gardens and Nairobi. Most of these were collected during the first six weeks of the expedition, as after this date, most of the plants had finished flowering. The specimens were preserved by pressing and drying.

An area of about one square mile of sediments, approximately ten miles inland from the present level of the Lake, was mapped in some detail. Samples of the different sediments were taken for analysis. Also the beach sediments on the Lake shore were surveyed and sampled in two places. Water samples from the Lake were brought back for analysis.

As area of about ten square miles of the volcanic hills near Ferguson's Gulf was mapped and samples of the different type of rocks were collected. The volcanics in this area are very complex but it is hoped that an analysis of the samples collected will help to elucidate their nature.

It took three days to drive to Lodwar from Nairobi in the Land Rover. The road to Kitale is tarmac and of good quality. From Kitale to Lodwar, (a distance of 230 miles), the road is dirt track. It is, however, easily negotiable in a Land Rover. There are two dangerous escarpments on the way and the road is badly rutted. The track from Lodwar to Ferguson's Gulf is only motorable in the dry season.

We took most of our supplies with us from Nairobi but most items can be bought in Lodwar. We found it advisable to order petrol in Lodwar, as the pump there sometimes ran out. Water is available only from wells so we always kept a good supply at camp.

The climate is very hot and dry. The rainfall is very variable but has averaged 5.7 inches over the last 28 years.

The botanists made trips to the River Turkwell and the Eminit Forest and several trips were made to Lake Rudolf in the Land Rover, but otherwise, work was carried out on foot.

References:
Expedition's Final Report

1968 EXPEDITION TO SIERRA LEONE

Three electrical engineers went to Sierra Leone to gather information from first-hand experience for a group project report as part of the Part Three Electrical Engineering course. They were accompanied by one mechanical engineer and two students from Fourah Bay College, Freetown.

The expedition sailed from Liverpool on the M.V. Apapa on Friday, 29th June. First class cabins had been allocated and a 25% reduction on the return fare given by Elder Dempster Limited. After nine days, we arrived at Freetown.

We were met at the boat by Mr. B.B. Ibraham who had been arranging the visit in conjunction with Mr. Goodlad of Imperial College. A state of emergency was unfortunately in force during the week we spent in Freetown, which restricted our movements to the environs of Fourah Bay College.

Most of the week was spent clearing things through Customs, arranging for letters of introduction from the Commissioner of Police and also the British High Commission, who were most helpful.

Building Technical Services, a branch of the United Africa Company offered to lend us a truck and driver to take us up to Kabala, our first stop on the journey to Yifin.

On Saturday, 12th July, we drove with the truck to Kabala, accompanied by Mr. Ibraham and the two Fourah Bay students who were to work with us on the project.

On Saturday evening, we stayed at the Missionary School in Kabala which was run by the religious organisation that we were to work with in Yifin.

On Sunday morning, we set off once again to drive the remaining fifty miles into Yifin. This time, however, we were in a Public truck, one of the many that provide the only means of transport in that part of the country. After a short time, sixteen people plus baggage, were in the small vehicle, on a road that had little surface and was very hilly. In all, the journey took five hours.

Yifin is a village of some three thousand inhabitants, and the seat of the paramount chief who is responsible for an area of approximately five hundred square miles. The main occupation of the people is farming.

The Missionary churches of America have a station there whose main purpose is to produce native pastors for the church and it was on its newly built Bible school that we first started work.

The Mission had already had installed a three-kilowatt diesel generator and this they ran for four hours each evening to supply light to the three houses in the compound. Our first job was to run a line from the generator to the Bible school so that the students would have light to study by in the evenings. (It became dark at seven in the evenings). This was a distance of five hundred and fifty yards and an overhead line was felt to be the simplest to use.

While this work was in progress, two members of the expedition overhauled a 15 K.V.A. generator which had been acquired with the view to expanding the medical facilities of the mission. Work was also begun in surveying the town.

Regular measurements of the river flow near the mission were made in the hope that a Hydro-electric scheme might be possible. It was found that there was adequate flow for nine months of the year to provide three-kilowatts from a very crude but inexpensive turbine.

After we had re-wired the three-kilowatt generator, we found that it was being used to only forty percent of its capacity. We then approached the Mission and suggested that we ran a line to the Chief's house. It was agreed possible if the Chief met the costs. After some time the Chief managed to get the necessary one hundred pounds together for the purchase of the material.

Two members then departed on the Sunday for Freetown to buy materials. Building Technical Services came to our rescue and offered us forty yards of three phase armoured cable for fifteen pounds, which was bought and the next five days was spent stripping the cable and unwinding the strands, (a total of 111 of them). These were joined together in pairs to make a total length of nearly two miles. The rest of the material was bought for thirty pounds leaving the Chief some change from his one hundred pounds.

Meanwhile, back in Yifin, the rest of the group had bee erecting poles and in the next two weeks, we installed the line and put lights not only in the Chief's house, but also in the Court House.

Two days after the ceremonial switching-on, we returned to Freetown. The final two weeks were spent visiting local industrial concerns arranged by Mr. Ibraham.

1968 EXPEDITION TO MALTA

General

In July 1968, nine members of Imperial College travelled overland to Malta. The aims of this expedition were twofold:-

1) to test the ability of a diver to locate the direction of a sound underwater
2) to evaluate some rubber inflatable tents ("BITES"), that were designed by members of the expedition.

Members

B. Ray, Mr. & Mrs. R. Leonard, B. New, P. Newman, J.S. Williams, J. Wilson, M. Day, D. Edwards.

1. Directional Hearing Tests

Three main tests were tried:-

a) An underwater sound source was switched on some 20 feet from and in a horizontal plane to, a 'blindfolded' diver. He was asked to point to the direction from which he thought the sound was coming from. A camera stationed 30 feet above the subject recorded both his estimate and the true direction. Variables that were changed included the posture of the subject, for example, for some tests, he was suspended upside down in mid-water, and the type of sound source. Over 400 photographs are at present being analysed.

b) The blindfolded subject was seated at the apex of an isoçceles triangle, that was marked on the seabed with a measuring tape. He was told that a sound would be generated from one of the other two vertices, and was asked to indicate which one. The angle between the two positions was altered as was the relative (fixed) position of the subject. Different sounds were tried, ranging from a single impulse to a continuous wide band source. A third diver with pencil and slate recorded the results. A total of about 1,500 results were recorded.

c) A pilot experiment was conducted to test the hypothesis that there was a significant increase in hearing sensitivity when the source was in front of the subject. This apparent increase was reported by several subjects while performing other tests. The equipment used for this test was largely made in Malta with components bought from the local radio repair shop.

Results

Although most of the results have yet to be evaluated, it is clear that a diver can locate the direction of a sound to better than 20°. This is in contradiction to the popularly held belief that directional hearing is almost impossible underwater. The pilot experiment showed a significant increase in hearing sensitivity when the subject was facing the source. This result was still held when subjects were asked to remove their aqualung from their back and hold it alongside themselves.

It must be emphasised that the results have not yet been evaluated. When they are, far more information should be available on directional hearing underwater.

2. A Report on Experiments carried out with "BITES" in Malta 1968

For many years, people have suggested that a diver ought to be provided with some kind of tool store on the seabed. Usually, a working diver takes the tools for a required task with him, but if he should encounter any unforeseen obstacle, he may find himself ill-equipped to cope with the new problems. A tool store actually on the bottom would provide him with both a suitable place to keep a whole range of tools, and if necessary, a refuge in an emergency.

Although this idea was first considered some time ago, very little constructive work has been done with it. This summer in Malta, a team of divers from Imperial College were at work assimilating the uses and potentialities of "BITES" (Benthic Inflatable Toolstore Enclosures). These BITES were, in general, cylindrical, being about three feet in diameter and three feet high. Two of the three we were working with were made of a rubberised fabric and the other of a strengthened polythene.

Putting aside the original idea of a tool store for a moment, the obvious use for a bag underwater is as a means of lifting. The team did occasionally use them as such; sometimes from depths of well over a hundred feet but they were also found useful as a lifting "beam". In this case, the BITE was firmly anchored about eight feet above its ballast an ' a system of pulleys suspended from it. Any object on the bottom could then be raised in a controlled fashion. By using two or three BITES at a time, the payload could easily be moved around as if on a travelling crane, without there being any fear of it rocketing to the surface.

In our work, we often used a BITE as a base for surveying. On these occasions, the BITES came into their own, providing as they did, a very convenient booth where divers could talk to each other and explain all the things normally inexplicable by ordinary hand signals. Further as a means of communication, a telephone was connected inside the BITE so a three-way converstion could be arranged - diver to diver, diver to ship, or diver to shore. We found that this modification to normal diving procedure could and, at times did, speed up our work considerably.

The telephone would also have been useful in an emergency. The BITE itself provided a refuge and if the diver then considered he required help, he would simply have to telephone. If, for example, anybody had run out of air at depth, the BITE was always near at hand - a convenient bubble. Also if a diver had been working hard and perhaps getting short of breath, he could go to the BITE to recover or rest. In this particular case, he could even partake of light refreshment. Although we never actually found this practice necessary, we did, as a test, eat a small snack inside the BITE. No after effects were noted - even on surfacing.

It seems probable that in the future, BITES or something similar, will become more and more a standard piece of equipment for working divers. During the course of the expedition this summer, BITES were moored and brought to the surface again several times over. As we became more practised in the art of handling them, we found that the whole procedure of "hanging" a BITE could be completed in under ten minutes - even at reasonable depth. The longer the task the more useful and efficient a BITE would prove. In saturation diving in particular, BITES would come into their own as surfacing would then be quite out of the question. In safety, economy of time, and diving efficiency, BITES can bring dividends which no firm seriously involved with diving can afford to overlook.

Mooring the BITE

SATURATED OFF MALTA

This account of the Imperial College 1969 Expedition to Malta, written by Claire Denise Barnes, a member of the Enfield College team, and Peter Newman, a member of the Imperial College team, is printed by permission of the Editor of "Triton", the Journal of the British Sub-Aqua Club.

"Day 4: Subjects appear quite normal! That is, large amounts of food have been consumed and requests for more are being made with alarming frequency."

One might wonder why the eating habits of two people should concern a 20-strong expedition team and six medical attendants, or require three years' planning, or seventeen aqualungs dumped on a barren, rocky peninsula!

Perhaps this will become clear when we say that these two men were actually living 20 feet below the Mediterranean off Marfa Point, North West Malta. Their world was a small inflatable house, moored in 35 feet of water, looking very much like a cottage loaf. Its strength lay in a tough nylon-neoprene skin attached to a steel frame. It could well be described as an "underwater tent".

The house was moored 130 feet from the shore, but it could have been 130 miles, for it was completely isolated with no airlines or power cables to the surface.

The heart of the system was a box, about the size of the average T.V. set. This contained the life support system which kept the two subjects alive and healthy. Inside were a pair of emergency batteries which powered a blower unit, the interior lights, and an air purification unti containing soda lime to remove CO2 from the atmosphere and activated charcoal to absorb trace impurities.

Oxygen was bled into the house from a cylinder resting on the seabed. The main power unit also outside the house, was a fuel battery generating electricity directly from $H_2 + O_2$ gases. It could run unattended for three weeks. The life-support module was exhausted after 24 hours and replaced daily.

The expedition was run jointly by Imperial College, London University and Enfield College of Technology. Its objects were to establish a light-weight underwater laboratory and to perform a short series of experiments while living beneath the sea. A life support system would be used that would make this the first house to be run independently of the surface.

The teams arrived in Malta towards the end of July, bringing the first of the structures strapped to the roof of the Enfield College Land Rover. Soon the base camp was established on Marfa Point and by early August, the first underwater house SDM Mark I, was moored 30 feet out in 70 feet of water, and the life support units had bee assembled and tested.

The Mark I house had taken four months to design and build. Many problems had arisen: for example, the construction of a frame sufficiently rigid to take the loads involved (the displacement of the house was estimated at eight tons), yet light enough to be carried by four persons. Another complexity was the prediction of the behaviour of the skin when subjected to tensions as high as 100 lbs. per linear inch.

It was this last problem that proved the most difficult to solve. Quite a number of mistakes were made initially, but we had learnt by our experience; a new skin had to be built before we left England and arrangments were made to construct a new type of frame in Malta, the combination of these becoming the SDM Mark II house.

By 17th August, we were nearly ready to begin the underwater living experiment. The Mark I house had been submerged for a week and it appeared as solid as a rock. Personnel had been inside it for periods of two and three hours at a time, assembling the complex internal frame supporting bunks, table and hoist, and during this time, the life-support modules had worked perfectly. The telephone link to the house had been established and conversation between habitat and shore was extremely clear.

On shore, members of the support team had been allocated their tasks in the event of any mishap, and a rota had been drawn up for the continuous watch which would be kept once the experiment began.

Wires for lighting, telephones and search-lamps snaked all over the rocks; the subjects were going yet again through the procedure for using CO_2 and O_2 meters.

A gentle Westerly breeze had been blowing all day and a long low swell had developed. Late in the afternoon, the wind strengthened and the sea became rougher with frightening speed. White horses came racing into the bay and breakers dashed against the low reefs.

Two of the most experienced divers kitted up and were in the water as quickly as possible to find that the structure, on its long mooring ropes, "was swaying about and jerking angrily". No attempt was made to enter the house; all we could do was to wait hopefully for the sea to subside.

That night, freakish gale-force winds swept across the island and the morning found 15-foot waves rolling into the bay, the shore installations damaged, tents down, large areas underwater and the diving ladder demolished.

By the following day, the seas had calmed enough for a brief recce dive. Our worst fears were confirmed; three of the six mooring ropes had snapped, the house lay on its side, partly deflated and with the fabric pierced by the internal hoops. The house, its mooring and the life-support unit were completely wrecked.

However, progress had been made on the SDM Mark II house during the past month. A frame had been quickly built of a simpler design, relying on a more sophisticated mooring system to spread the loading. The tricky task of attaching the skin to the frame had fortunately been completed the previous week.

Within only one week of the disaster, it was "all systems go". The Mark II house was moored at 20 feet and the fuel cell was on the seabed 10 feet below. A life-support unit had been installed and internal fittings had been built up on the spot, using Dexion.

But the Mediterranean had not finished with us yet! Once more a long swell built up, the prelude to an even more violent storm. However, the few brief hours' warning gave us time to weigh down the fuel cell, remove the internal structure, deflate the Mark II and tie it down to the seabed. We watched the storm increase in ferocity - then without warning it subsided, the air was perfectly still and the sea like a mill pond.

Due to these delays, we were working against the clock to get the divers into saturation. The expedition personnel were operating for 14 and 15 hours a day, and late in the evening of 31st August, the first diver went down to the house.

There are as yet no text books written on how to run an underwater house, nor even any tables stating when a diver becomes saturated. All we can say is that sometimes during the next couple of days, we crossed this line.

The economics of saturation diving have been spelt out many times; the decompression time for a saturated diver is a constant, independent of the working time, so the ratio of working time to decompression time can be made large. We were not working at depths where this economic argument could be applied, but this does not detract from the validity of the experiment.

From 1st to the 4th September, there were two divers living in the house. Life inside was similar to that of a small caravan. On entering, the diver left his aqualung tied to the mooring ropes, and climbed in. A freshwater shower, a towel-down and some dry clothes, usually shorts and shirts, enabled him to remain in a dry and pleasant condition.

Food, and even wine, were brought down regularly, and the occupants brewed up their own coffee and chocolate, and often invited visiting divers for a "cuppa".

Because air was not being pumped into the house, the source of considerable irritation in previous experiments, that of the sound of air bubbling out, was avoided. All was quiet except for the purring of the air curculation, the occasional splash of a fish jumping into the house and the ubiquitous "snapping shrimps". Sleep was disturbed each night at about 4 a.m. for readings of CO_2 and O_2 concentration. Apart from this, there were no complaints of sleeplessness.

In this thoroughly satisfactory environment, work began. The first priority was to complete the interior arrangements and thoroughly check over all the equipment. A "wireless" telephone link, the first of its type to be used, was established to the shore. When these initial tasks were satisfactorily completed, the divers started the work in hand.

The main project was a research experiment on diver hearing for the sea is not the silent world of popular myth. A diver can, for instance, hear the sound of his companion's breathing above the general crackle of the aforementioned shrimps!

Tests were carried out "in the wet" by divers from the house and delicate instruments were used "in the dry". Many of these operations were recorded on film, some of which was shown on television in Britain; also a telephone call was made from the house to Imperial College announcing our success.

The house was in operation for nearly a week and five divers spent over 200 hours underwater, living in the habitat. The longest continuous period spent by one diver was four days. This was considerably less than we had hoped.

As a result, the organisers are considering the possibility of operating the house in U.K. waters. The team is still largely complete and much of the equipment is readily at hand. All that is required is the means to bring the house back from Malta and continue the experiment here.

IMPERIAL COLLEGE ANDEAN VOLCANOES PROJECT

Most of the aims of the 1969 Imperial College expedition to the Andes were successfully accomplished. A long wheel-base Land Rover, equipment and stores were shipped to Valparaiso in Chile, where they were met in August 1969, by three members, (P.W.F., M.P.C., P.R.C.), of our team, who experienced considerable difficulty and delays in getting them through Customs. This was finally achieved because of Official recognition of the nature of our project - a five-month geological mapping and sampling programme in a volcanic area of North Chile, near the Bolivian border. Obtaining, organising, and transporting the food and equipment necessary for five months was, as usual, the most time-consuming aspect of the venture, with the vehicle often near to being dangerously overloaded.

All supplies were driven up to Antofagasta, where we were joined by the fourth member of the party (J.R.), and by Dr. George Walker, a vulcanologist and member of staff at Imperial College.

The area we worked in is high (10,000' - 20,000'), but not too rugged. Most of the mountains there are volcanoes, some of which are relatively recent and fresh, and some of which are older and more eroded. There is not much water, but the weather is good for most of the year, and the snow-line is at 20,000 ft. There are few inhabitants. Roads are unsurfaced, and mostly nothing more than dirt tracks. Large amounts of pumice and other volcanic debris make driving over open ground very difficult. The British-owned Antofagasta-La Paz Railway, however, crosses the area, a fact which made getting supplies in, and geological specimens out, far easier than it might have been otherwise.

Two weeks were spent in getting used to the altitude, and in general reconaissance, aided by Dr. Walker and Chilean geologists. After this, the mapping and sample-collecting proceeded smoothly. With considerable help from Railway personnel and the staff of various mining companies, most of the area was visited. Several volcanoes over 17,000 feet high were climbed; these presented no technical problems, but merely logistical ones. Covering ground at those altitudes was time-consuming, the problem being to establish suitable base camps and supply depots, and to ensure an adequate water supply. One interesting side-line was the activity of sulphur-mining companies in the area, the sulphur being associated with the vulcanism. We visited two of the active mines.

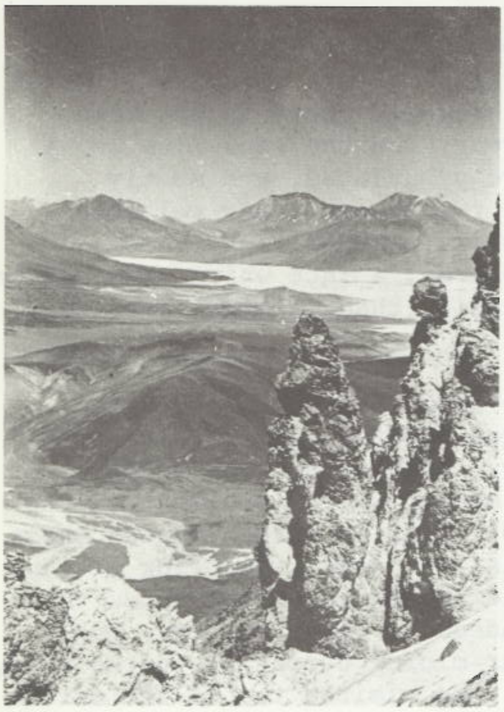
By December, and just before the start of the rainy season, the project was completed. Five hundred samples were despatched to England, and most of the food supplies had been consumed.

We started another phase of the Expedition, a survey of the feasibility of further work on Andean volcanoes, with general observations on their environment and structure. This took three months. Most of the travelling was done on the Panamerican Highway, large stretches of which are badly surfaced or in poor repair. The Land Rover gave more trouble than it should have done, particularly in Peru, where we also travelled the Inland road betwwen Lima and Cuzco.

Prospects of volcanic work in Ecuador and Colombia were discouraging, and we decided to concentrate on Central America, where volcanoes are generally more active. By this time, we had severe doubts about the Land Rover's future potential, and so shipped it back to England, with some of the equipment. We then went on by air to Guatemala. For financial reasons, we had to reduce the number of people in the party and after a tense, democratic draw, John Roobol was elected to return to England directly from Colombia.

In Guatemàla, the rest of us climbed, studied and photographed two erupting volcanoes, comparing their behaviour with that of their dormant or extinct Chilean counterparts, as deduced from a study of their products. We found the areas more accessible than in Chile, but more difficult to work in, because of the thick vegetation.

The return to England was made via Mexico City. P. Francis and M. Coward flew back from there, while P. Cobbold travelled overland to New York. Fortunately, the vehicle, our equipment, the geological samples, and much exposed film, all arrived safely as well, enabling us to carry out a subsequent research programme, the main contribution of which will be the chemical analysis of 150 specimens of the volcanic rocks of Northern Chile.



Rock pinnacles on Ollague above the flat white Salar de Ascotan contain a large proportion of sulphur.

Sulphur mine, summit of Ollague.

Active fumarole

IMPERIAL COLLEGE VOLCANOLOGICAL EXPEDITION TO ICELAND 1969

In November, 1968, four first year geologists of the Royal School of Mines, conceived the idea of an expedition to Iceland. After a couple of months discussion, we selected the volcano Oraefajokull in south-east Iceland as the most appropriate site to permit us to study our principle interest of volcanology. This area gave us an environment suitable to an expedition with a mountaineering basis.

Geoffry Wadge, from Burnley, was elected leader. He looked after the expedition equipment and was an experienced climber and caver. Ian Boughton, from Brighouse, Yorkshire, took care of transport and food supplies. Stephen Sparks, from Shipley, Yorkshire, took charge of photography and also had much climbing experience. Clive Newall, from Penith, a member of the Keswick Mountain Rescue, was the most experienced climber.

On Monday, 14th July, we flew in a Boeing 727 on Icelandair from Abbots Insch, Glasgow, to Keflavik, Iceland. We had already arranged for the Iceland Steamship Company to ship the bulk of our equipment on the M.S. Gullfoss ahead of us.

On arrival at Reykjavik, a taxi driver solved our accomodation problems by transporting us to the local Salvation Army Hostel, where we stayed for two days, during which time we organised future travel arrangements, reclaimed our equipment from Icelandic Customs, and sorted the provisions we required for the first phase of the expedition. The accompanying map shows the routes and locations of our seven-week stay.

On Wednesday, the 16th July, we caught one of the infrequent but efficient buses which took us along the south coast, past Selfoss, to a small village called Kalfholt. We pitched camp for our first night under canvas, on the flat southern plain in the light of the low midnight sun. Next morning, we attempted to hitch inland and north to the volcano Hekla. In the light of this particular day and subsequent events, hitching is not recommended in Iceland. Icelandic roads are notorious for economical use of road metal, use of river beds, lava flows, and their noticeable lack of traffic.

Fortunately, after many hours of walking, a converted meat wagon took us to a camp site beneath Hekla itself. Here we looked at some of the recent eruptive products of Hekla, a volcano which has erupted ten times in the last 1,000 years. We noticed particularly the form of the 1947 dacite lava which was then the most recent product. Of course, since we were there, Hekla erupted again in May, 1970. On the second day, we made an abortive attempt to climb the 5,300 metre summit. Unfortunately, we did not allow ourselves sufficient time as walking over recent block lavas is both a tedious and hazardous business. However, we reached a 3,500 metre ridge, and viewed some of the most spectacular volcanic geology and scenery in the world.

On Saturday, the 19th July, we attempted to hitch further inland to the hot spring area of Landmannalaugar. Hitching proved to be even more difficult and two of us had to bribe a farmer to take us there, when the situation got desperate.

Landmannalaugar ia a glacial valley, cutting through rhyolite and basic massifs. At the head is a very thick and very recent dacite lava flow with fumarolic springs. Hot springs and fumaroles are visible over a large area. The valley has been filled with a classic braided glacial river. The scenery, in its glory of mountain ridges, lava flows, cappings of ice, and fierceness of colour, is magnificent, and the area is classic ground for many volcanic and glacial features.

During our eight days, we hoped to familiarise ourselves with the principle features of Icelandic geology. We camped light, and took the minimum of food and equipment. Unfortunately, our programme was controlled by exceedingly poor weather, culminating in a 36-hour storm. However, we had an interesting visit to Eldgja Fissure in an Icelandic friend's Dodge. This fissure, 30 kilometres to the east, is a post-glacial fissure similar to the more famous Laki Fissure. As well as absorbing the main features of the valley, we enjoyed bathing every evening in the bath-warm pools, fed by the hot springs, at the head of the valley, even in the rain.

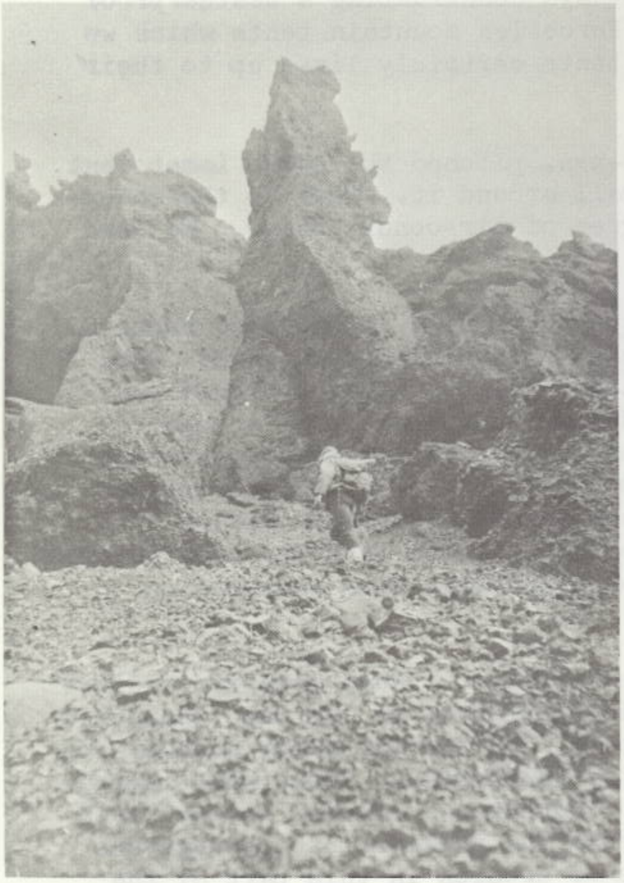
On Sunday, the 27th July, we took no risks and caught the weekly coach which takes tourists to and from Landmannalaugar. It should be noted that Landmannalaugar is uninhabited and is 75 kilometres from the nearest farm. The coach took us back to Reykjavik via a caldern lake, the Gullfoss and a welcome tea of fresh food on an Icelandic homestead. During the torrential storm, the rivers had swollen to frightening proportions. The coach helped us to rescue an Icelandic fanily whose Dodge had been literally swept away at a ford.

Back at Reykjavik, we reinstalled ourselves at the Salvation Army Hostel which, in the true spirit of that organisation, appeared to cater for Icelandic alcoholics, drug addicts, down-and-outs, as well as the occasional University expedition! The above mentioned establishment is, however, highly recommended for its hospitality, magnificient Scandinavian-style breakfasts, economy and colourful inmates.

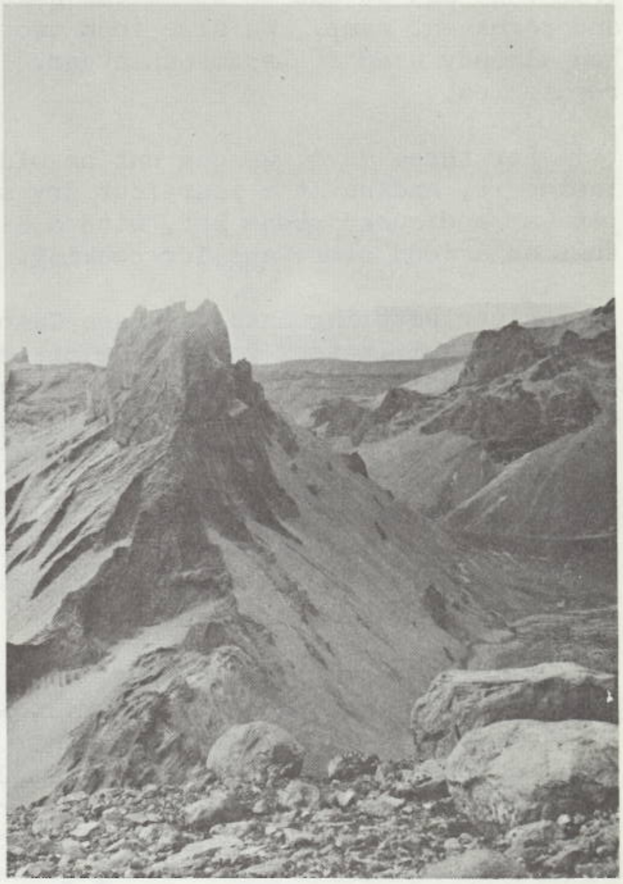
On Wednesday, the 30th July, having scoured maps and arranged air transport for our equipment, we set sail for Hornafjordur on the south-east coast. The two-day boat journey via the Westmann Islands was in the 80-ton Herjolfur, which the Icelandics mysteriously considered seaworthy. There was a strong storm and our little ship pitched and tossed uncomfortably. In the lower cabins, we were all very sick, not having a notable sailor amongst our numbers.

At Horafjordur, we successfully hitched a lift with a milk wagon to within 10 kilometres of our destination of Oraefajokull. A farm lorry took us the final jump to Fagurholsmyri, a collection of farms, crofts, a supermarket, and an air-strip at the southermost tip of Oraefajokull volcano. Here, we found that our equipment had arrived. We had arranged for a local flight to transport it from Reykjavik to Fagurholsmyri airstrip.

The following day, a friendly farmer took the equipment to our proposed Base Camp at Hof farmstead, 4 kilometres to the west of Fagurholsmyri. Here we set up the camp near Hof, right under the shadow of the area we proposed to study, that is, Hofsjfall, a peak on the lower slopes of Oraefajokull. We had taken a large Andre Lamet Frametent which we used for sleeping and copying up the day's field work. The first night, a very strong storm collapsed the



Sub-Glacial Explosive Breccia erodes at a quick rate, making Oraefayskull difficult country to map.



Gooayfall, an 800 metre summit, is composed of a single Rhyolite Lava. This is one of the largest single flows recorded.

Walking past a recent lava flow (Centre) at Landmannalaugar frametent and we had to spend the next three days constructing a weatherproof and permanent camp. We also took two Vango Force Ten mountain tents which we had already used at Landmannalaugar. These tents certainly lived up to their reputation.

For three days, we dug out an old sheep-pen, pitched the Andre Lamet tent inside it, and built a four-foot dry stone wall around it. Next to the sheep-pen was a disused stone hut, with a high degree of air-conditioning. We used this as a food store and for cooking.

After settling into the Base Camp, we spent the rest of the time engaged in our principle task of mapping the south-east slopes of Oraefajokull. The weather was again poor and it proved quite a struggle to cover a significant area. The geology proved most absorbing and rewarding. We found a huge complex of extrusive rhyolite, the largest of which is apparently equivalent in size to the largest flow yet recorded (700 metres thick). Many eruptive products and minor intrusives occurred. These were essentially olivine bearing basalts. Many showed structures showing that the lava had been intruded into the ice. This Moberg Formation is a characteristic rock sequence on Iceland.

Geomorphologically, the area had immense interest. Huge glaciers radiate out from the summit of Oraefajokull, which is covered by an Ice Cap, connected to the immense Vatnajokull Ice Cap to the north. We had two minor sojourns on the glaciers, and the Svinafjelljokull and the Falljokull. These were incredibly informative and rewarding, as none of us had seen a glacier in the field before. Also fierce glacial streams cut across the valleys into precipitous gorges and demonstrated the very quick rates of erosion in this part of the world. The Sandur Plain, covered with braided streams, lay between the volcano and the sea.

Apart from the tenting, for lighting and heating, we used butane gas equipment, which proved good value and convenient. We used Fairy, Everest Mummy, sleeping bags. For waterproofs, Ian Clough cagoules were invaluable in the wet conditions. For rucksacks, we each used Don Whilan's climbing sacks and Karrimor Totem sacks. We would advise future expeditions, incidently, to take two pairs of boots in such terrain as Iceland.

We took a large supply of food with us from England, mostly in the form of canned and dried foods. Food in Iceland, especially in remote parts such as Oraefajokull, is expensive, apart from local commodities such as fish and milk. Future expeditions are also advised to take more than a tent pole and a pin to fish with, as Icelandic trout are surprisingly perceptive.

At the end of 18 days, the local farmer took our gear back to Reykjavik. Here we ran into some luck. The plane was full of Icelandic musicians for a festival in the East. Packed out with musical instruments, they could not fit our luggage in. So we had a free flight along the south coast to Hornafjodur, where the musicians alighted, and then back to Fagurholsmyri to collect our equipment. It was a clear day and we had magnificient aerial views of the Vatnajokull. We eventuall got back to Reykjavik and again accepted the hospitality of the Salvation Army Hostel.

After tying up business with Reykjavik, we set sail for Britain on the M.S. Gullfoss and after a three-day voyage, arrived back safely in Leith.