

(A Local Group within the Geologists' Association)

## Newsletter May 1999

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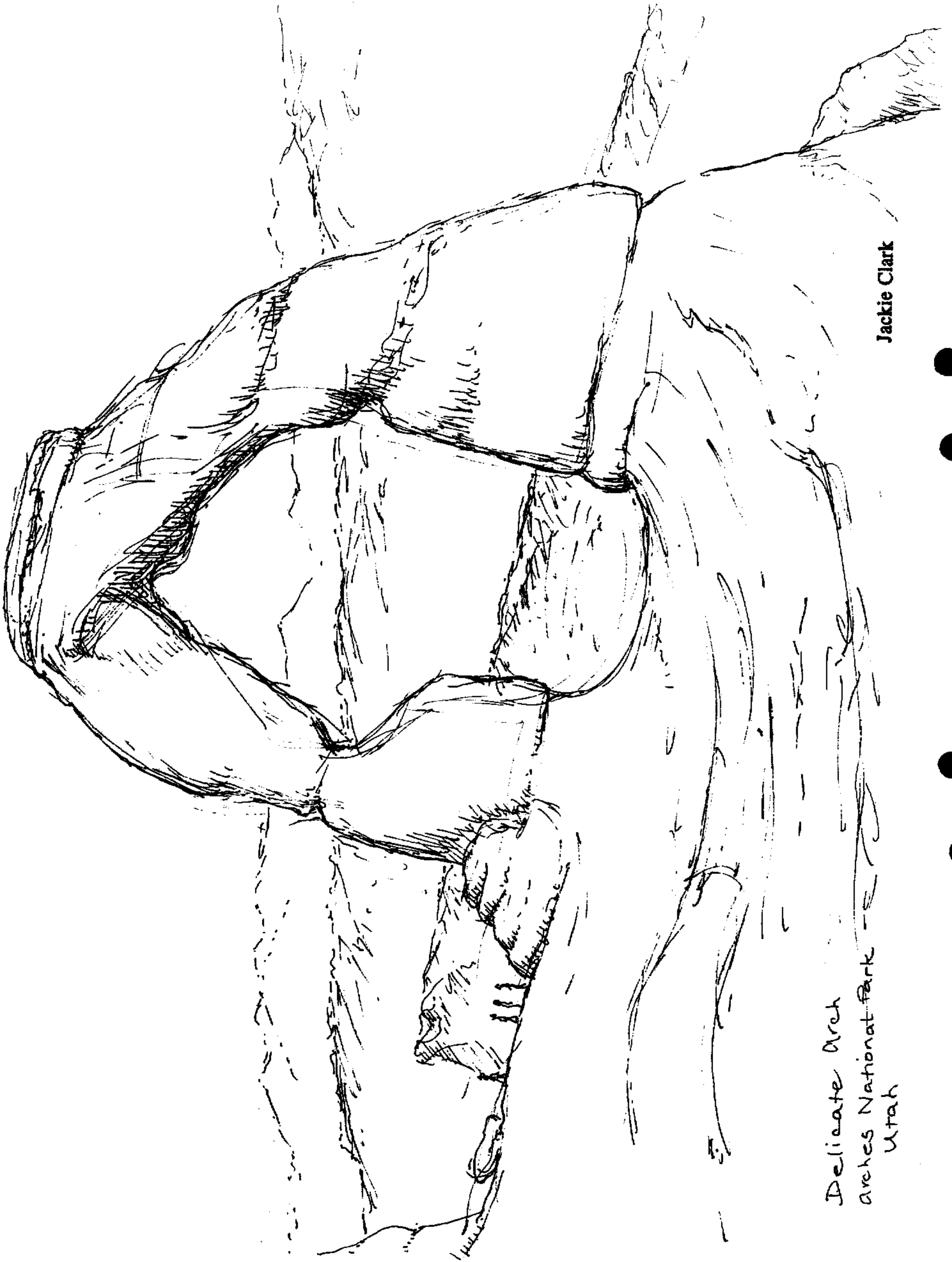
Hot on my note (no pun intended) about Global Warming in the last newsletter, came the geological episode which made the headlines in most of our national newspapers; the cliff fall at Beachy Head. Of course Beachy Head has been crumbling away over the centuries but never so well recorded. The consequence forced withdrawal of Belle Tout lighthouse en bloc made fascinating viewing.

At our last lecture Mary Darling brought us indirect evidence of the threat of coastal erosion to our shingle beaches. Near Bognor Regis shingle was removed and large blocks of Norwegian Larvikite laid down and then covered with the shingle. These may puzzle geologists late in the next century when the blocks reappear. Mary had two fine hand specimens of this rock as fresh as they were quarried. Already the footings of the cliffs at Barton-on-Sea are protected by blocks of Portland stone.

We have to thank Joan Prosser for her final instalment of her excellent Iceland Diary, Alan Comer for a Visit to Crete and Jackie Clark for her pen and ink sketch of Delicate Arch. Those who were on that tour will remember it as being the hottest day of the trip, with a relentless sun in a clear blue sky and no shade anywhere worth the mention.

On 24 February six members of our society attended a one day course on 'Caring for your geological collections' at Haslemere Educational Museum. This was organised by Dr. Paul G. Davis of Surrey Museums Consultative Committee. Accommodation, which was fully taken up, was for a total of 25 attenders. It lasted from 9.30 am to 4.00 pm and demanded attention throughout. There was a coffee break and a larger break for lunch at which all food was provided such as sandwiches and various drinks. We were able to use some of the reagents the professionals employ, on our own specimens or on those provided. We learnt that there is a great deal more to labelling than just putting on a blob of white paint and writing on a reference number in indian ink. One should never label with materials that cannot be removed as a later date. Each of us was given a loose leaf folder of about 100 printed pages with different coloured sections according to the various aspects of curation. At the end of the course a valedictory address was given by Diana Hawkes the curator of the museum. Furthermore those of us who wished were taken behind the scenes in two parties and showed the enormous size of the whole collection, far more than is normally seen by ordinary visitors. It was a most interesting and enjoyable day's outing.

David Caddy



Delicate Arch  
Arches National Park  
Utah

Jackie Clark

## Iceland Diary - Final part

The caldera is gigantic, covering 50 sq.km. We walked for about 2km. over various lavas including A A lava from the 1961 eruption, passing cinder cones en route. Much of the caldera surface was covered with snow to a depth of about 30cm, making walking quite difficult. Our destination was Öskjuvatn, Iceland's deepest lake, and Víti crater, which lies close by it. Víti produced one of the largest pyroclastic rhyolite eruptions in Iceland's history, hurling out 1.8 cu.km. of ashes. The crater now holds pleasantly warm water. A few of us swam in the sheltered lake. The water was cloudy and sulphury, with a rocky floor covered in a fine, ashy sediment which was unpleasantly soft underfoot. The air-fall welded tuff at the edge of the crater is evidence of the past eruption, and vents on the walls of the crater are building up a good collection of sulphur and other crystals.

### Sunday 19th July.

Reykjahlid to Egilsstaðir, in the Eastern Fjörd area.

We visited Namaskard geothermal area, with its steaming vents and boiling mud pools. Not far away is a power station, using the steam to generate electricity. Our next objective was a walk within the caldera of Krafla, a shield volcano to the north of Reykjahlid. Krafla has erupted many times, and the Krafla "Fires" are notorious in Iceland, associated with earthquakes and fissure swarms. Tuff is exposed around the caldera; also conspicuous are ring dykes and many eruptive fissures. Apparently drilling shows that xenoliths in the tuff become abundant below 1.2 km.

Our 6km. walk took us over the 1980 lavas, three episodes, the third of which produced lava covering 12sq km. The most recent flow of 1996 was clearly distinguishable, draped over previous deposits in many different forms and shapes, including those known as "Danish pastries", one of which now graces my mantlepiece at home! Beyond the more recent flows, vegetation was becoming established, and carpets of lichens and flowers such as moss campion gave welcome colour to this otherwise stark scenery.

### Monday 20th July

Egilsstaðir to Höfn, via Breiddalur; a drive around the Eastern Fjörds.

The coach carried us round hair-raising hairpin bends beside precipitous slopes. In the icy wind coming from the huge icefield of the Vatnajökull, we stopped to look for zeolite minerals in the roadside basalts. The views were beautiful; a mountain stream flowing down the cliffside to the valley far below.

Breiddalur is in the central volcano area. A section through the core of the volcano is visible from the road, and we were told there are 5,000 dykes along the 20-mile section. We didn't stop to count them. Nunataks give a turreted appearance above the steeply sloping basalts. On the coast beside the fjord at Breidalsvik we found columnar jointed chloritic ignimbrites lining the beach, adjacent to mountainous deposits of basalt lava.

We identified arctic tern, whimbrels and eider ducks.

From our school accommodation at Höfn (ladies dormitory) we had a glorious view of a snout of the Vatnajökull glacier in the distance, across fields of GRASS. That evening, we ladies sat and drank a toast to the view.

### Tuesday 21st July.

#### Höfn to Hof.

Travelling in a south-westerly direction, we were able to pick out cone sheets, seen as sloping dykes in exposures of lava flows. The cone sheets were paler in colour, and clearly visible against the basalt lavas. Samples of gabbro and pegmatite were picked up as loose rocks in the area. Some gabbro contained large crystals of plagioclase feldspar and augite. Epidote was also present, olivine gabbro, and veins of aplite were common. We learned that cone sheets often develop into ring dykes through cauldron subsidence.

At Jökulsárlón we went for a boat trip among icebergs in a lagoon. The icebergs break off the glacier snout, which advances on average 100m. per annum. Some of the icebergs were a beautiful shade of blue; others were decorated with fine black vertical stripes, which we were told represented layers of volcanic ash, and demonstrated that these icebergs floated on their sides. On this occasion luckily the sun came out, and we were able to appreciate the picturesque scene to the full. This is the best Great Skua territory in the world, and we were lucky enough to see one of these awesome birds quite close-up. Another was found lying dead on the nearby beach, allowing an even closer view. The large claws attached to its webbed feet we examined with interest, and sympathy for its prey. Snow bunting adults and juveniles we also spotted locally.

We viewed the great Sandur plain at Skeidarársandur. It stretches over 1,000sq.km. across the region where floods from below the glacier have washed out gravel towards the sea.

That evening we made the most of the daylight and went puffin watching on Ingóffshöfði, which becomes an island at high tide. For me at any rate this was a unique experience. We rode, standing up, on a farm truck pulled by a tractor through sandy marshland, across a beach of black sand, then a stretch

of shallow sea to the island. Hundreds of puffins inhabit this island as well as their enemies, the great skuas. My photographs of the colourful birds against a background of black sand and bright sea have turned out really well; thankfully the weather stayed fine for us.

Wednesday, 22nd July.

#### TRAVELLING FROM HOF.

A lovely sunny morning. We drove along the new road which replaces the one washed away by the floods in 1996, after an eruption below the ice. The terminal edge of Skeidadbara glacier, with its dark volcanic ash decoration, sparkled in the sunshine. We tried walking on the icy surface. It proved extremely difficult, but we persevered. A wide range of rocks and minerals was found in the moraine. Hulanite crystals were among the samples I found. Merlins flew overhead, and yellow alpine saxifrage grew nearby.

At Haalda, a large crater in the coastal plain was thought to be created by an iceberg, broken off the glacier in the late 18th century, and now completely melted away.

At Skaftafell National Park, next on our itinerary in the Southern region of Iceland, the vegetation is quite lush in places. We climbed a path to the top of Spartifoss waterfall, through an area thick with grass, small trees and bushes, and many wild flowers. The snow on the slopes of the distant mountains glistened in the welcome sunshine.

Later in the day at Kirkjugolf, on the northern side of the great coastal plain, we came across sea-washed prismatic columnar jointing; a mini-version of the Irish "Giant's Causeway", miles away from the sea, proving that it once flowed over this vast area.

Our overnight accommodation on this occasion was a hut, with BUNK BEDS on the first floor. A wall divided the ground floor into a dining area for us, and a barn, where bundles of hay and farming implements were stored, - and to our delight - three arctic fox cubs were being reared, free to come and go as they pleased.

Saturday, 25th July.

LANDMANNALAUGAR TO REYKJAVIK.

The cathedral church of Skálholt was our first stop. This is the latest in a series of churches built on the site since 1056 AD. The design is simple, and contains some beautiful locally made stained glass, and an impressive mosaic behind the altar. A violinist was practising alone in the church, and the quality of his playing was so good that some of us stayed for a while to listen. I heard Andrew Manze playing again after we returned to England. He was the soloist performing in a Prom. concert on BBC TV. No wonder we marvelled at the superb tone in that church in Skálholt.

We travelled on to Selfoss; one of the five towns in Iceland NOT on the coast. Our route took us through a thickly vegetated area, fed by old lavas and river silt. The coastal plain is covered with windblown volcanic dust over well drained gravels.

At Raufarholshellir cave (Peter had to repeat this spelling six times), we investigated a large lava tunnel, and as before, found lava stalactites suspended from the roof.

We travelled on to Reykjavik, on the way visiting the so-called "Blue Lagoon", a warm outdoor swimming pool beside a large power station, aesthetically not to be compared with the river at Landmannalaugar. Nevertheless, we went for a swim - for novelty's sake I suppose. This pool is very well organised, with changing rooms and showers - and a cafe. It seems quite a good use for all the spare warm water which is a by-product of the power station. The bottom of the pool is almost pure kaolin. Lots of other tourists were enjoying the experience, but I wouldn't recommend swallowing the water!

Finally, we arrived at Reykjavik, and spent the night in a relatively SUMPTUOUS hotel - the "Loftleider"; very comfortable, with all the trimmings. For some strange reason we felt we deserved it - en suite rooms - hair driers - I'll say no more.

Sunday, 26th July.

We had a half day for sight seeing in Reykjavik. The unique art-nouveau "Hallgrímskirkja" church was interesting and beautiful. This great building dominates a large part of the town, its artificial stonework resembling columnar jointing. I wonder where that idea came from? I spent some time there, and then went on to investigate the "Pearl"; a domed observatory, not astronomical as I first thought. Positioned on a hill beside the town, the dome is made of glass - and revolves! Tourists (such as I) may walk around various art exhibitions, sit drinking coffee or eating a meal while

the dome gently moves around, and different aspects of Reykjavik and its surroundings are laid out like a constantly changing mural. This clever idea is not new, but beneath the dome, six enormous cylindrical tanks store millions of gallons of geothermally heated water; enough to supply most of the needs of the town.

Our memorable two week's tour of Iceland was at an end, and we had seen a great deal of this "land of fire and ice"; certainly enough to realise that this description fits well. We could hardly believe after living in virtually constant daylight for two weeks that quite soon, in fact by the end of August, the sun would be setting by six in the evening, and during the winter it would be light for only three hours each day.

The Surrey countryside looked unbelievably green when we arrived back home,- and the TREES!... There is a saying in Iceland, "Two trees make a wood, three trees make a forest, and if you are lost in Iceland, just stand up!"

The figures and historical facts above are either quoted directly from Reg or Peter, or are taken from John W. Perkins' "Geological Field Guidebook of Iceland" 1989, or Michael Bamlett and John F. Potter's "Icelandic Geology", 1988. The map showing our route is copied from the itinerary notes supplied for the tour.

Joan Prosser.

## A Visit to Crete by A.T.F. Comer

Crete is a long, comparatively narrow island, situated east-west across the southern end of the Aegean Sea. It is the largest of the Greek Islands.

From a geological standpoint it is there as a result of the collision between continental Africa and continental Europe, which created the modern geography of the region. But long before the collision took place, Crete began as a long strip of subsiding continental shelf in a warm sea, on which there accumulated a great thickness of sediment made up largely of calcareous material and mud, which in the course of time became limestone with mudstone inclusions.

Long afterwards, when the slow but relentless progress of Tectonic movement initiated the collision, a whole continent had to be brought to rest, releasing vast amounts of energy that raised the Alpine mountain belt, and changed the boundaries of the continents in fashions that are still not fully defined. The fragment of continental shelf that is now Crete was also jostled in the process, generating enough heat and pressure to change much of the limestone into low-grade marble in which most of the original bedding is obliterated, and the mudstones into schists. Finally uplift took place that raised these metamorphosed rocks high above their original level to form the mountains that we see today, probably much higher originally than their present 3500m as there is evidence that there has been quite severe erosion since the land appeared above the sea.

Other things also happened throughout the present Mediterranean region at that time. Vulcanism became widespread - indeed Thera, often called Santonini, the first island north of Crete, is still an active volcano, and several other islands in the Aegean Sea show clear signs of recent vulcanism, but not Crete, where no volcanic rocks have been found. It has also been discovered that the entire Mediterranean was blocked off from the oceans at least once, possibly twice according to some researchers, so that, because rivers were insufficient to maintain the water level against evaporation, a series of shrinking lakes were formed that must have come close to drying out completely, accumulating great thicknesses of evaporites which are now the evidence for their existence. A huge deposit of Gypsum at the eastern end of Crete is attributed to this cause and has been quarried for the past three thousand years right up to the present time.

That is a bare outline of the Crete described in Geological history, but the picture can be enhanced by archaeological evidence because people have lived there, and have left records or artifacts for at least the past five thousand years, using local rock for their buildings, obtaining local minerals, cultivating the soil, pasturing their animals, and enduring repeated earthquakes because the island is still seismically active. At least once they were also subjected to the effects of a devastating volcanic eruption in their neighbouring island to the north, where at that time they had a prosperous colony that was completely destroyed.

With a background like this, Crete cannot fail to be interesting.

This was certainly true for a small party of us who were able to visit Crete last spring, with mainly geological leanings but with an archaeologist and historian present to add to the interest. We arrived from Gatwick late on a fine afternoon, and were immediately impressed on the road from Heraklion Airport to our hotel, first by the schists through which the main



road was cut, and then by the marble that began to appear in roadside cuttings, and finally by the snowcapped mountains we could see in the last of the evening sunshine.

One of our first excursions was to the western end of the island, through a pass in a low mountain range on to the fertile coastal plain where oranges, nuts and tomatoes are grown for export. Here we were looking for the site of a small Roman seaport, probably a fortified harbour to guard against the pirates that are known to have menaced Cretan settlements. It was used for a couple of hundred years, until their occupancy was abruptly terminated in 365 AD by a very severe earthquake that raised the harbour floor right out of the sea. We found the site, marked by a few ruined Roman buildings, with what we took to be the bottom of the harbour now just part of a field, and from the site we could clearly make out a raised beach that convinced us that the western end of Crete must have been lifted by about four metres since that time, probably most of it in that single earthquake. Later during our stay we were also able to visit the eastern end of the island, staying for a couple of nights in the delightful little village of Mochlos. Here too we could see some interesting geological history. About 3500 years ago it is known that there was a spit of land at this point, projecting into the sea, terminating in a rounded hillock that would have provided a good defensive view both ways along the coast. Here the Minoans built a little town, with two harbours for their ships, one on each side of the spit to provide shelter no matter which way the wind was blowing. But the spit no longer exists - we had to be rowed over from Mochlos to examine the hillock, which is now an island, but the building walls and streets of the Minoan town are still there in surprisingly good condition considering the time since they were built. All this was equally convincing evidence that the eastern end of the island had been thrown downwards by much the same amount that the western end had been raised, and all in historic times!! Clearly Crete is being tilted to the right (facing northwards), and it would hardly be prudent to conclude that movement has now ceased.

Not far from Mochlos is the enormous working gypsum quarry overlooked from the main road, gleaming blindingly white in the sunshine, but not far away also is one of the most spectacular faults to be seen anywhere, running in a north/south direction for several kilometres across the flanks of a series of hills. Close examination shows it to be a normal fault which exposes a slip-face four to eight metres high on which slickensides and scrapes have not yet been weathered away, showing once again with reasonable certainty that the fault is of fairly recent occurrence. A viewpoint along the line of the fault reveals another feature that is not at first apparent. The scarp is not quite a continuous line, but consists of a series of very slightly curved segments each about 800m in length, overlapping the next in line by a few metres at a distance of 15 to 20m from each other.

The mountains forming the east/west spine of the island consist almost entirely of limestone or low grade marble that is often closely jointed, and sometimes shattered to the extent that bedding is only observed with great difficulty over wide areas. This is the factor that led to many of the erosional features that make the island unique, arêtes and corries at high altitude carved by snow that might well have been more severe in the past than at present, and many steep-sided valleys and deep canyons excavated by meltwater and surface run-off that provide fascinating but often strenuous walking which is usually rewarded by finding little archaeological gems to show the involvement of people in the past. There were bridges built in Hellenistic times, monasteries in impossible caves, ancient water tanks that are still functional taking advantage of natural springs, and the walls of buildings some of which may

have been built literally thousands of years ago. Clearly long ago people had to adapt to and take advantage of the natural geology of the region if they were to live prosperous lives.

Features that most of us had never seen before were the 'Dolines', of which there were many examples in the high mountains. Dolines are another consequence of erosion, but they are peculiar in that they arise when water drains inwards from mountain ridges towards the centre to join low-level water tables under the shattered rock. This gives rise to roughly circular and surprisingly flat plains that can be very fertile, varying in area from about the size of a tennis court up to areas over a kilometre across, entirely surrounded by hills through which there is no breach for drainage. They often have a prominent sink-hole somewhere on the floor. Dolines tend to accumulate a lot of snow in the winter, so that the smaller ones are used only for summer pasture, but the larger ones have pleasant villages in lovely surroundings, and are more extensively cultivated. In one we found a small modern settlement with not far away the intact walls of some ancient buildings lacking only roofs to make them useful, but very close to them was what remained of an expensive modern house, the lower floor of which was crushed downwards leaving the upper story dangling unsafely above it, the result of a severe local earthquake only a few years ago that left no other visible damage apart from the shattered house. In the course of our visit to Crete we looked also at several important archaeological sites including the famous Minoan Labyrinth at Knossos, parts of which have been restored with great skill (and, I think, some imagination), to make it a very moving experience for any visitor, but even here there were geological gleanings to be found. For example, among the ruins there is a stone staircase made of large blocks of the local gypsum, walked on by the Minoans in the distant past, and recently by countless thousands of visitors, yet showing very little sign of the wear that might be expected in such a delicate stone. The path of the conduit that brought water into the city/temple complex can be traced from hills some distance away where there were springs adequate for their needs, and there were obviously engineers who understood local conditions, and craftsmen to work the rock from which it was all built. There was at least one example of an old stone block being crushed by the weight of new restoration work above it, but also interesting were overturned stone pillars and columns found at several sites, some being clearly broken when they fell on their sides, but others showing angled fractures characteristic of severe end-shock loading, suggestive of several severe earthquakes in historic times since they were erected although the chronology has still to be unravelled. However, it should not be concluded that earthquakes are an everyday occurrence, as history spans a very long time in that part of the world, but there is still a lot of work to be done on the seismic and geological history of the island.

There is no doubt that Crete is an ideal venue for a field trip for anyone who enjoys archaeology and geology in any combination, the geological side being particularly interesting provided fossils are not important - we did not see any in the course of our visit. I very much hope to go there again some day, and will look forward to continuing this paper when I get back.