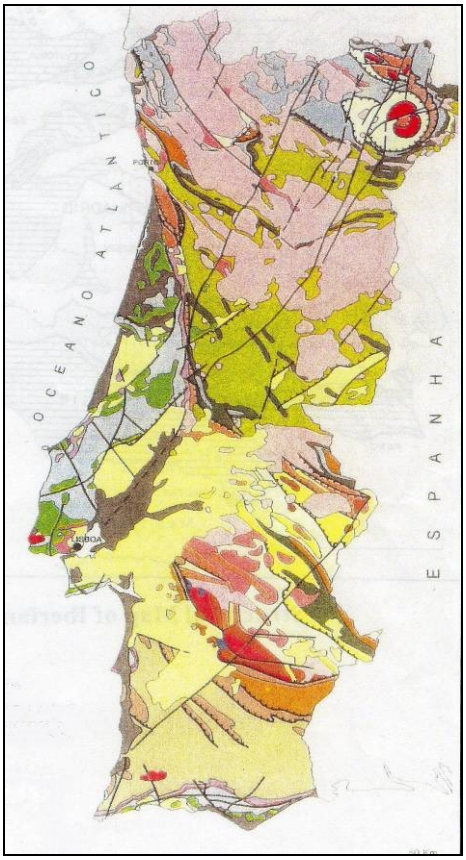
Special Proceedings of the

Reading Geological Society

Field Trip to Portugal
25th September to 2nd October 2008



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Introduction

This is the seventh overseas field trip undertaken by the RGS.

Portugal as a destination was suggested by a talk given by Lesley Dunlop of RIGS "The Granite and Mineral Deposits of Portugal" in February 2007, Lesley agreed to lead a trip for the Society in 2008.

The trip was divided between Setubal, a coastal resort to the southwest of Lisbon and Coimbra, an inland University town 160km to the north of Lisbon, close to the Serra des Estrela and the mining regions.
These proceedings are a chronicle of the member's reports on the excursions, both geological and otherwise.

Our thanks are due to Lesley Dunlop who provided excellent leadership for the group, despite our struggles with geochemistry and the finer point of igneous geology, as well as providing a truly excellent handout.

Thanks are also due to David Ward (Field Secretary), and David Riley (Treasurer) for the all the hard work dealing with language problems, Portuguese coach companies and hotels, for the organization of this trip.

Those contributing were: - Alan and Jane Lane, David Ward, David Riley, Chris and Clare Fone, Louise Knight, Carol Gregory, Irene Davison and Christine Hooper. Also in the party were: - Norman Gregory and Christine Eden.

Christine Hooper
Editor.

Portugal 2008 – Lourihna Museum

Top row. Left to right – Irene Davidson, Louise Knight, Leader Lesley Dunlop, Clare Fone, David Riley and Norman Gregory.
Front row – Christina Eden, Carol Gregory, Christine Hooper, David Ward and Chris Fone.
Alan and Janet Lane not present.

And not forgetting

Paol, our driver.

Outline Geology of Portugal.

Portugal lies on the western side of the Iberian Peninsula and it's important to recognise that there is no natural boundary between Spain and Portugal. The greater part of the Iberian Peninsula is made up of strongly folded and partly metamorphosed Hercynian (Variscan) rocks.

The oldest rocks outcrop in northern Portugal. Proterozoic rocks outcrop in several areas but the most notable ones are in the peneplain known as the Estremadura and give rise of the land of cork oaks and scrub such as round Evora. The rocks consist of thick sedimentary sequences, which have been metamorphosed to mica schists, quartzite and marble. There is a straight sedimentary passage from Precambrian to Cambrian. Certain horizons within the Lower Palaeozoic rocks stand as prominent ridges of quartzite.

Portugal has a range of magmatic rocks – in the north there is a predominance of granitic rocks, chiefly calcalkali, porphyritic and biotitic. To the south the intrusions become more basic in nature and there are many outcrops of gabbro, diorite, serpentine and anorthosites (Beja ophiolite complex).

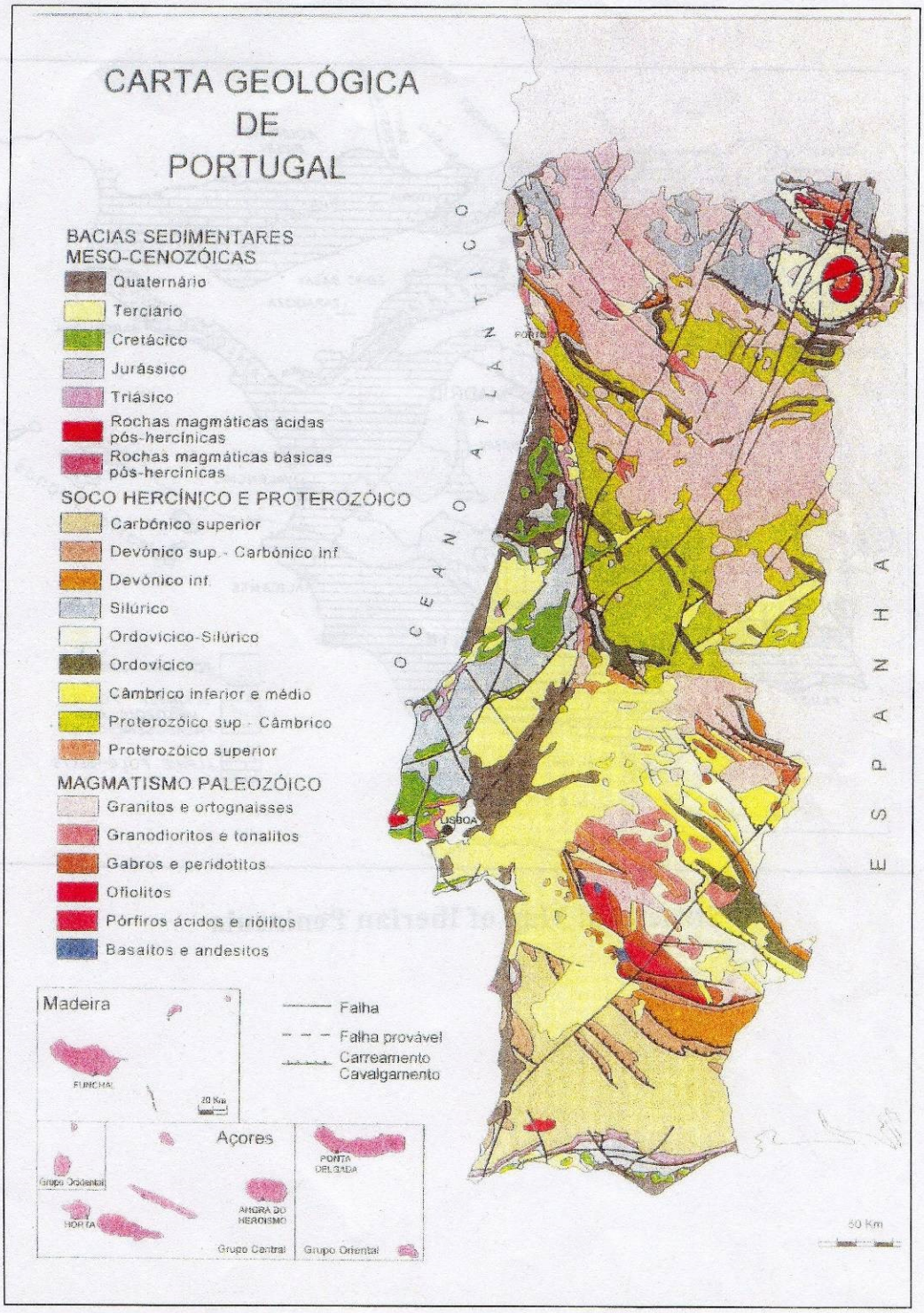
Mineral deposits are found in different rocks e.g.: precious and base metals associated with Cambro-Ordivician volcanic – sedimentary rocks, tin and tungsten associated with granitic complexes and chrome, nickel, cobalt etc. in the basic and ultrabasic rocks.

The Mesozoic rocks of the Portuguese Lowlands consist mainly of Jurassic and Lower Cretaceous deposits although some Triassic is seen. Around Coimbra there are yellow dolomites of upper Triassic are and these pass into limestones and shales of the lower Jurassic. The sequences around Figueira da Foz are excellent examples of the lower Jurassic.

In the Upper Jurassic there are thick carbonate sequences, which have been much quarried around Setubal. The Lower Cretaceous marks a return to shallow water shelly sands (e.g. Cabo Espichel) and carbonates (Boca de Inferno). The Iberian Peninsula was a positive area during the Upper Cretaceous and as a land area during the Tertiary. The Mesozoic rocks were gently folded during Tertiary and more recent times.

There are also late Cretaceous and Tertiary volcanics, which occur at intervals along the Atlantic coast and cause localised metamorphism. Lisbon is partially built on an area of Tertiary extrusive basalt.

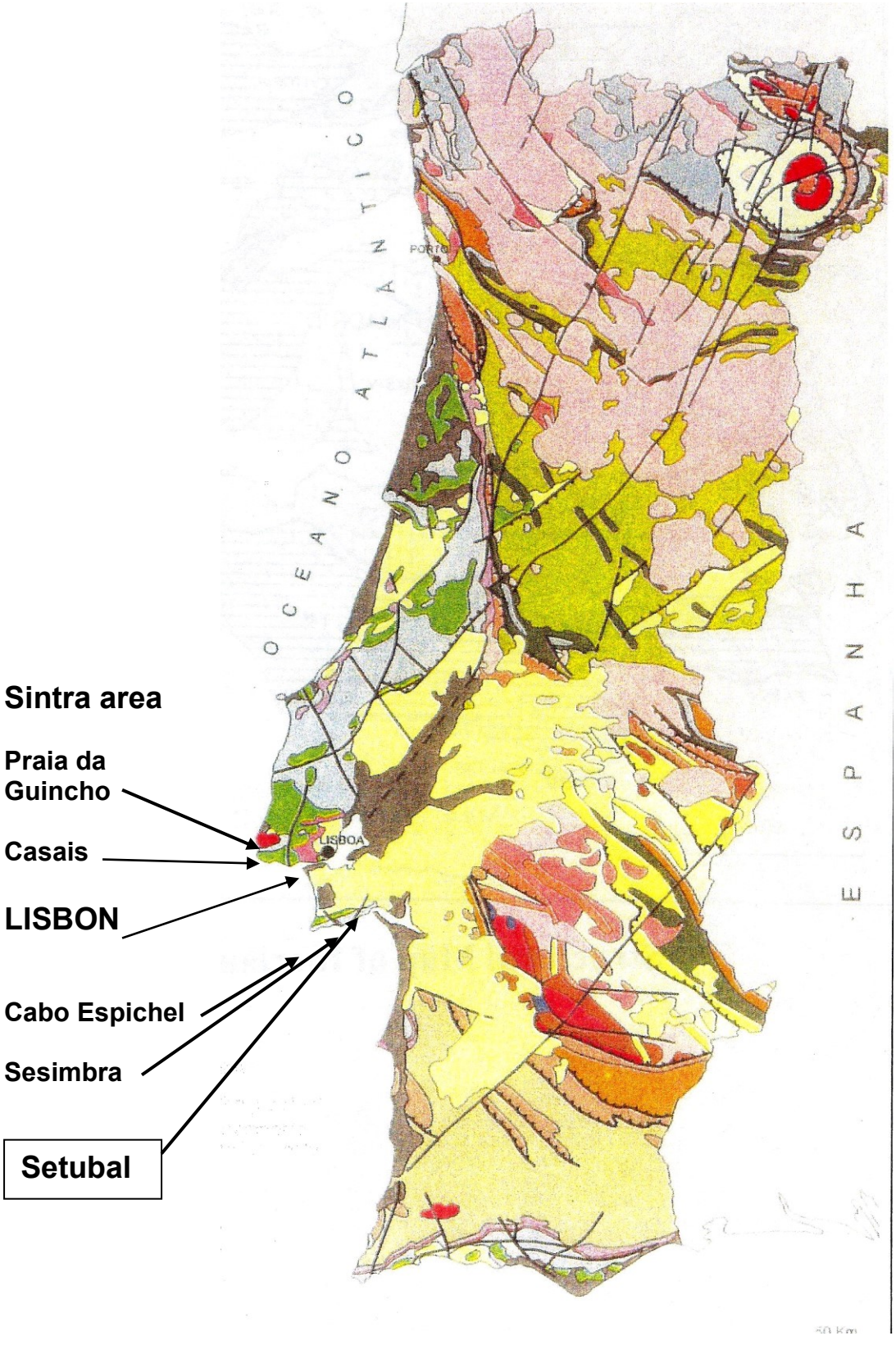
Lesley Dunlop.
Reprinted from the Portugal handout.



Lesley Dunlop

SETUBAL

Approximate locations of sites



Thursday 25 September p.m Setubal

Due to our early arrival at the Esperance Centro Hotel, Setubal we were unable to move into our rooms. Abandoning our luggage in the lobby we looked for coffee and food. Setubal is an old fishing port, now seaside resort for Lisbon, full of cobbled streets and alleyways. Our group wandered until they came to the main square with its cafes.

Tired as we were we were soon engrossed in examining the cobbles and stones, which patterned the square, drawing attention from the locals and the chagrin of the ‘living statue’.

The cobbles are rather cleverly recycled - by digging them up and turning them over - the passing feet then polish them up to a high sheen.

After close inspection the light brown were thought to be local limestone; the black – although a passing local said basalt- we thought it more likely to be a dark limestone as basalt is not common and indeed, on returning home, the ‘acid test’ proved it to be limestone.

In the larger red slabs, a mudstone, slump features could be seen and in another grey-brown limestone (which Lesley said came from Mafra) gastropod fossils which were unidentified.

In the afternoon, a coach trip round the local geology had been arranged. A drive around the headland and over the Arrábida Range, where Jurassic limestone was thrust over the Miocene during the Alpine Orogeny some 17Ma to 16Ma(earlier in this part of the world than our 20Ma), which would be featuring in later trips. By taking the high route we were given beautiful sea views over the beaches and rocks we would look at during the next few days. A, not so beautiful view, of the large cement quarry in the Jurassic Limestone which would introduce Paol our driver, to the idiosyncrasies of geologists and to fossils.

A quick stop to admire the view at the foot of Convento de Arrabida

The last stop was at Castle Palmela, where fossils were found in the limestone of the walls, the ruined chapel a reminder of the Lisbon Earthquake of 1755.

Reported by C Hooper

Friday 26th September a.m. – Cascais and Sintra
Boco da Inferno, reef limestones and terra rosa.

On a perfect warm, sunny morning, we left Setubal by coach for the Lisbon peninsula and the Sintra Massif. The oldest rocks in the area are of Upper Jurassic age, followed by a fine series of Lower Cretaceous sediments deposited in the Lusitanian basin, approximately 160Ma. At this time the Atlantic Ocean was not present, but small seas, which may have been connected with each other, covered the area.

The earliest deposits would appear to have been laid down in moderately deep water, but by the Early Cretaceous times the Lusitanian basin was gradually filled and lacustrine conditions prevailed. The total thickness of Jurassic and Cretaceous sediments is about 2,200m.

The area was affected by tectonic events that lead up to opening of the Atlantic Ocean and the intrusion of the Sintra Massif in late cretaceous times.

Our first stop at Boco da Inferno, a beautiful coastal section of an eroded Cretaceous limestone platform with a series of “blow holes” which, in rough weather, produce a booming sound which can be heard over a wide area, but on the occasion of our visit the sea was like a millpond. The cliffs in part are composed of reef limestone separated by layers of mudstone.

An interesting feature was the layers of terra rossa, a red clay soil developed on limestone associated with karst features in areas of strong seasonal variation in rainfall, which forms when limestone dissolution occurs in the wet season when clay and iron compounds are released. The red colour originates from conversion of hydrated ferric oxides to haematite during the dry season.

The only fossils found at the exposure were a few small oyster shells and a fine series of trace fossils, which included tracks and burrows.

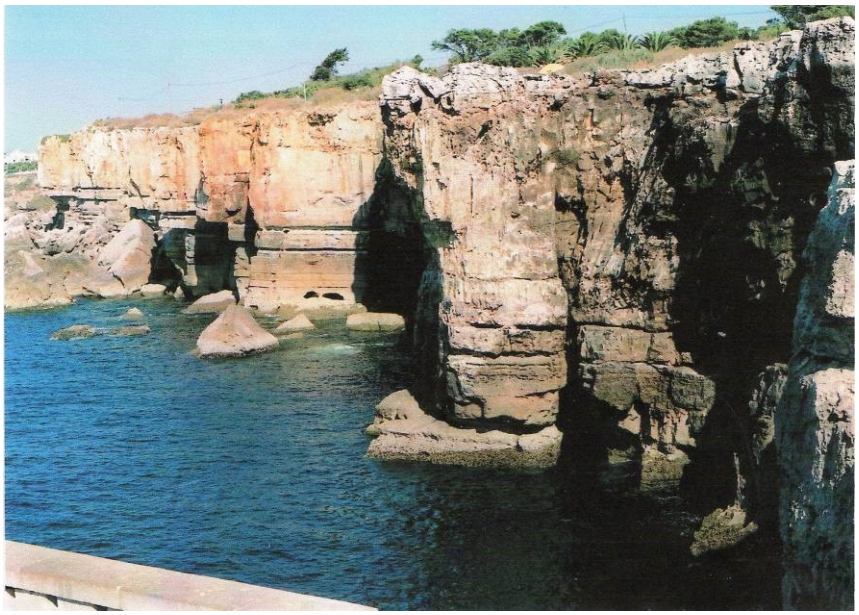


Photo Alan Lane Boco da Inferno

Our second stop of the morning was at Capo Raso Lighthouse and the party was able to walk the section to Guincho beach. The headland gives its name to the Cabo Raso Formation, 130-126Ma, Hauterivian. The lowest 30m is dolomitised, but walking northwards the limestone was found to contain a good range of fossils, including colonial corals of several species and stromatoporoids

which lead us to believe that reefs occurred in the area. Other fossils noted were rudist bivalves, brachiopods and echinoderms.

As the party left the beach at Guincho, we passed through a wonderful area of beach and sand dunes, the accumulation of unconsolidated material dating from the Quaternary to recent times, which runs along the coast between Cabo Rosa and Praia da Guincho.

After a very interesting morning, the party were ready for a very good lunch in the village of Guincho.

Reported by Alan and Janet Lane.

Friday Afternoon, 26th September 2008

After the coach driver had led us astray into a Restaurant in the old town of Guincho we were all encouraged to leave the delicious puddings and jump back in the coach. Some of us were less keen than others to leave, particularly those who had found a tasty bottle of local wine to consume! We found the coach and piled-in ready for our short journey back to the Praia da Guincho.

Praia da Guincho – Stop 1
We gathered at the Hotel and restaurant area at the southern end of Praia da Guincho. The beach was a long sandy bay that was clearly popular with holiday-makers; with the hot and glorious sunshine there was a moment of jealousy from some of the RGS Group and regret that that too long had been spent in the Restaurant to allow a cool swim in the sea.

Figure 1; Praia da Guincho looking north with the Sintra Massif in the background

The southern edge of the Bay was the west/east axis of a syncline, referred to as the Alcabideche Syncline, created by the intrusion of the Sintra Igneous Massif about 5 miles to the north. The Praia bay itself (looking north as in Fig 1) was upper Cretaceous sediments gradually getting older as the syncline rose on its northern side. The Sintra Massif itself could be seen rising from the far side of the bay although it was explained that there were upper Jurassic sedimentary layers exposed at the northern edge of the syncline before the igneous rocks become dominant rising up to the west/east ridge of the Sintra. Marble mines apparently existed at the junction of the Jurassic Limestone and the igneous rocks and formed a west-east line along the escarpment where many of the villages still exist today.

The igneous intrusion occurred in the late Cretaceous, approximately 90MY BP. The intrusion had left its mark all along the bay area and a small number of dark rocks in the surf adjacent to the middle of the beach are believed to be the remains of a volcanic plug from the same period.

Stop 2
A short walk to the west following the northern flank of the Hotel complex, adjacent to the beach, led us over a rough wooden bridge and onto the main Cretaceous sediments. These had originally been laid down in a small sea basin, referred to as the Lusitanian Basin, and on which we had been walking in the morning.

We stopped to look at the limestone rocks, which were on the sea edge and dipping at about 30^{o} to the north. This dip was consistent on all the rocks in this environ and seemed to conflict with the geological map evidence. The map suggested this location was about the axis of the main syncline and thus the dip should have been horizontal or dipping slightly to the south. It is thought perhaps the map was locally in error and the syncline axis was further north along the bay.

Figure 2: Stop 2 looking west with shallow Cretaceous limestone dipping north

The Limestone beds were highly bioturbated with many large burrows that had been exposed in three dimensions by the action of the sea.

Stop 3
Continuing a clamber along the cliff edge following a wall to our south we eventually reached the western point of the small promontory. Near the far end of the wall there was an opening allowing a view of the small sea inlet to the south. The inlet had been terminated by the Hotel swimming pool protective wall but on the far side of the inlet was the remains of an igneous dyke (see Fig 3). The dyke basalt had been less resistant to the action of the sea than the limestone and all that remained visible were the vertical walls of the dyke which had originally been about 8 m thick.

Fig 3, Eroded dyke in the inlet referred to in Stop 3

Stop 4
The group retreated back to the edge of the beach and walked down some steps onto the warm sand where sunbathers were enjoying the good weather. We followed the small cliff base westwards parallel to the route taken to Stop 2.

In one area of the cliff there were Karst-created fissures and eroded holes with a sand infill that appeared to be resistant to the sea action. The sand had been bound together by calcite cement and probably originated from a Pleistocene environment.

The location of the main site to be visited was beyond a piece of exposed cliff with waves occasionally barring the route. A few brave members attempted to second-guess the waves and sprinted around the cliff, some misjudged the waves however and got round but with damp socks and walking boots.

Immediately beyond the exposed cliff was another eroded dyke, in this case only about 1 m thick, but running as a shallow cave deep into the cliff. We followed the cave with its vertical walls for about 20 m southwards where it finally terminated, reputedly under the Hotel Complex at its northern wall. See Fig 4

Fig 4, Eroded dyke cave in the southern cliff of Praia da Guincho

Stop 5

The planned itinerary was to walk the length of the beach and examine the northern cliffs. These were still Cretaceous limestones but being much closer to the Sintra up-lift they were far more fractured together with calcite mineralisation. Unfortunately time didn't permit this visit to be made and we retreated back to the coach for the long trip back to Setubal and after all the sea air some of us enjoyed a nap ready for the evening 'activities'.

Compiled by Chris & Clare Fone

Saturday 27th September. Setubal, Sesimbra and Capo Espichel

Pria de Figuernho – Upper Jurassic and Lower Cretaceous sedimentary deposits

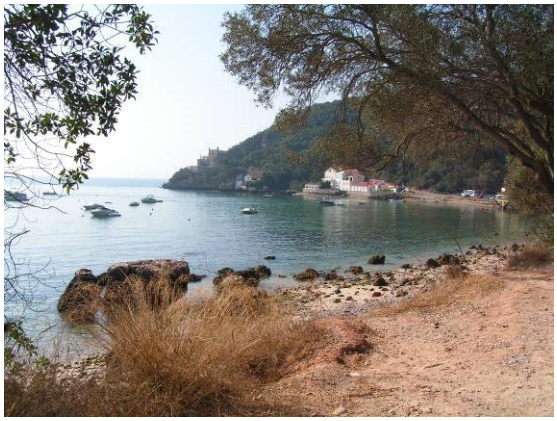
The Arrábida Mountain Range is the best example in Portugal of Alpine movement, the Miocene being over-thrust by the Jurassic. Portugal still has active earthquakes due to the continuing effect of this movement.

An early start saw the group on a deserted beach, Pria de Figuernho.

The cliffs behind the beach and parking area showed the sedimentary deposits of the Upper Jurassic (Turranian / Cornbrash equivalent) so faulted that some of the rocks had been converted to rubble.

Our goal, however, was a beautiful example of a fault breccia. This contained breccias coming from distant sources, the surf line providing nicely washed samples.
The explanation of the origins of this breccia was to be revealed at the next stop.

Portinho da Arrábida – unconformity between horizontal Miocene and dipping Jurassic.



This pretty little beach can be very busy in season, the lower beach road becomes one –way and vehicles are not allowed onto the front, but we visited out-of-season. The narrow road down to Portinho winds between rocky cliffs (the people sitting on the left admired the rocks at close range) and steep drops, which had the group on tenterhooks, but our driver was more than a match for the road.

Our first stop was a group of large boulders some 200m to the east of the beachfront restaurant. The boulders were of a conglomerate showing grading, different clast sizes, cemented with calcite indicating a river or marine environment and are Miocene. The Miocene here tends to be variable but is mostly a whitish-yellow colour marine deposit of 3-4 my. There are no muds. Lesley introduced us to a new word, 'biocalcarenite', meaning a calcinarious rock of marine deposition containing fossils.

The walk to the eastern end the beach to our next stop, gave us views of the angular unconformity between the horizontal Miocene beds and the overlying, steeply dipping ($55^{0)}$ Jurassic limestone.

The large blocks, some 500m along the beach, which had fallen from 50m up the cliff face, presented quite a challenge to the group. They appeared to be a conglomerate of limestone blocks with fossils; shell fragments, oysters and a bivalve (which was definitely Miocene) mixed with a Jurassic reef coral (a type not found in the Miocene). Just to confuse matters more, there were pebbles in the matrix, which is unusual. The group, with Lesley's help, came to the conclusion that it was a limestone mud, which had an influx of pebbles and clasts from the Miocene, the coral being eroded from the Jurassic.

The groups returned to the restaurant for a well-earned cold beer and lunch - it had become rather hot - only to discover our driver had had orders to move on from the front. So we returned up the road (the people sitting on the right had the close-up view of the rock) and continued to our next stop.

Capo Espichel – dinosaur tracks

Capo Espichel, at the southern tip of the Setubal peninsula has been a place of pilgrimage for 800 years, the Sanctuary was built in the 17th Century for pilgrims is now used as a venue. There is an ancient local legend that the Virgin Mary came ashore at the bay, where a handy mule carried her up the steep cliff, leaving a trail of hoof-prints. In Britain, these would be the Devil's Hoof marks! There are, indeed, prints but they are dinosaur tracks.
When we arrived a market was getting underway. Lesley warned us that the fossils on sale were probably faked; there were some rather nice trilobites on one stall. The group resisted the temptation.
Lunch was taken at the foot of the Sanctuary walls over- looking a small bay, the headland opposite showing clearly the boundary of the marine Jurassic and the terrestrial deposits of the Cretaceous.

To see the tracks, there was a walk of 2-3km. back down the road toward Lagosteiros, turning left at the signboard and following the track down to the headland.
From this vantage point we could look across the bay to the Sanctuary and the tracks climbing the cliff.

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These tracks were laid down in the Cretaceous (Portlandian period) calciclastic sands in a protected lagoonal environment. At least two sets of tracks were seen but difficult to identify at the distance.
Lesley then said that further footprints had been found on our side of the cliff, so the group split up and started to search.
We found a bed that contained a death - assemblage of large gastropods (D.Ward found a really large fossil gastropod) it also contained corals and oyster shells.

The track way

Three-toed theropod

Eventually, it was the non-geologist (but keen-eyed and nimble) member of the group who found the tracks. They were on the same line as the vantage point but nearer to the sea but still on the bay. There is a structure (notice board?) from where the tracks can been seen. The more agile members of the group scrambled down for a closer look.

One set of footprints, a three-toed theropod, were each around 20cm in length with a stride of

1-2 m., which ran for approximately 10m. The second set, which are possibly sauropod and ran at right angles to the first set.

This site is incredibly rich in tracks and would be well worth a longer visit.

On the walk back we stopped briefly to examine a Pleistocene deposit of cross-bedded sands. After a swift drink we returned to our hotel in Setubal.

The evening saw a thunderstorm and torrential rain!

Reported by C Hooper.

Sunday 28 September 2008
Sintra Peninsular

Sintra is a small town on the landward side of the Sintra Headland, popular with geologists because of the igneous intrusion, which forms the high ground. The intrusion is about 5 x 17 km and is 90 m years old – comparable with the tertiary intrusions in Skye, which are about 60mya.

Peninha

Peninha is a Refuge built in the 14/16 C on top of an outcrop of the igneous rock, which forms the Sintra headland and Sierra. The rocks exposed here are mainly syenites, but with granites and diorites subsequently intruded into the syenite. This intrusion is associated with the Atlantic Opening, which started here about 90 mya, compared with 60 mya for the Atlantic Opening associated with the UK. Also happening at about the same time was the anticlockwise rotation of the Iberian Peninsular to create the Bay of Biscay. These two movements resulted in the local Jurassic strata being lifted, so that there is now a dip to the S of about 60 deg.

Another effect of the intrusion was the metamorphic alteration of some of the Jurassic Limestones into inferior marble, subsequently worked in local quarries and visible from the Refuge to the SW.

Driving up the hill to the refuge, we were able to observe brown granites exposed in the roadside, but as we progressed to higher levels, these became grey coloured syenites.

Syenites have no free quartz, but increased concentrations of feldspars with alkali metals, compared with granites.

Having arrived at the summit, we left the coach to discover that a gale was blowing, although the sun was flying in a very blue sky. Examination of outcrops to the SW of the refuge revealed a dark grey rock with major feldspars and minor quartz, but no mafic minerals, a “quartz syenite” – one of those border rocks designed to trap the unwary geologist!

These rocks were intruded at a depth of 3 km, the evidence for this being that no –OH containing minerals are present. A temperature of about 700 deg C is required to melt this rock and allow its intrusion.

An intrusion carrying much –OH would be expected to rise further and crystallise later.

A short walk down the track to the W allowed us to move onto a basalt which was cut by 2 -4 cm veins of syenite, allowing us to conclude that the basalt was the older.

Further west still, we moved onto granite, completing the examination of the rock types at this site.

A short drive brought us to Cabo da Roco, the westernmost point in mainland Europe and marked by a significant lighthouse.

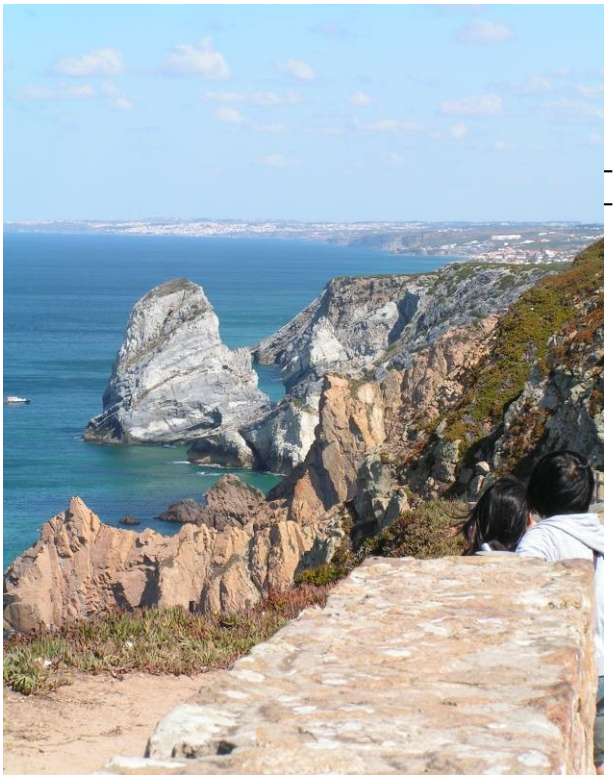
Cabo da Roco

To our surprise, Cabo da Roco was humming – with a very large gathering of immense motorbikes – it is a recognised gathering point for the Portuguese equivalent of Hells Angels. Much revving and manoeuvring, black jackets, strange headgear and mutual admiration of machines – the RGS felt somewhat outclassed!

Lunch was eaten at various places – some in the visitor centre, some on the grass – possibly with surreptitious looks at the bikes – some on the rocks.

The N side of the top of the headland was our first stop.

Here, brown stained granite was seen against a much finer grained, pale coloured rock and it did not take us very long to start saying “dykes” and closer examination revealed a second set which cut both the granite and the first dyke identified.



View to north

The view along the coast to the N was spectacular

- nearest to us was a brown granite outcrop,
- behind this (further to the N) was a white and grey rock, the Jurassic marble, then beyond this was the unaltered grey Jurassic limestone, dipping W at 40 deg, the result of the granite intrusion.

Dykes to south

We moved a short way to the E round the headland, where more dykes were found.

These were also fine grained, but carried both biotite and tourmaline crystals. The tourmaline minerals contain boron, which it is proposed was collected from the sediments through which the rhyolitic magma passed.

Some large, white coloured patches on the rock faces were first attributed to vandals but further consideration showed that they were in fact patches of siliceous materials. This material had passed through the joints in the rock in solution, before being deposited within the joint. The falling away of one side then revealed the ‘sinter’

The party now re-boarded the coach for our transfer to Coimbra, our base for the second half of the visit.
On the way, we saw the Castle at Leiria, built on an ultrabasic plug, but unfortunately obscured by trees. The castle at Pombal also sits on a similar plug.

Our route up the A1 gave good views to the E, where we could see the higher ground consisting of uplifted Silurian and Ordovician sediments - faulted from the coastal plain on which we were travelling The long ridges of white, Ordovician quartzite reminded the travellers of the Stiperstones in Shropshire – a very similar rock in a similar geological setting.

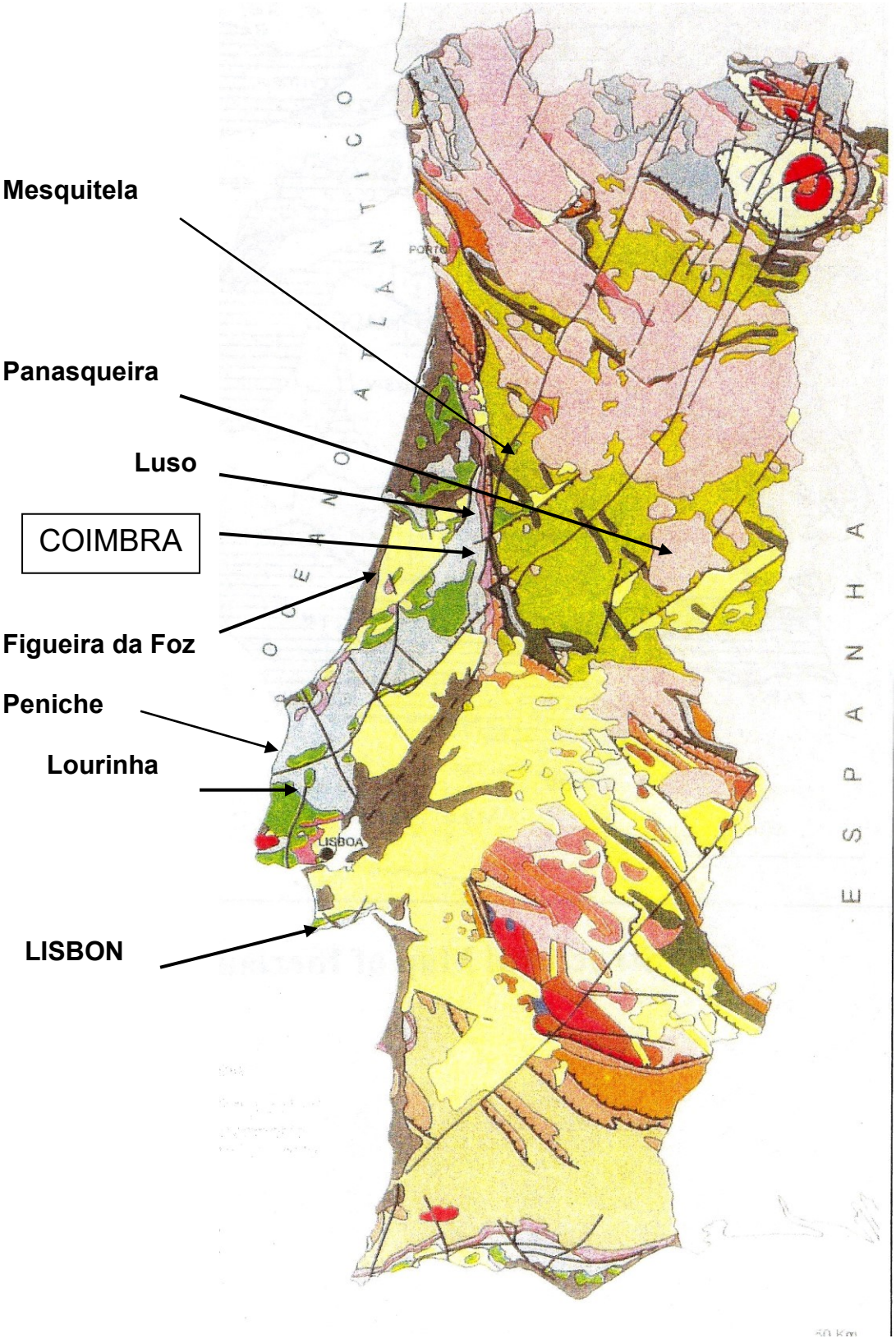
Coimbra

Coimbra when we arrived did not disappoint -an ancient University on top of a hill, narrow winding streets paved in mosaics of small white (limestone?) cobbles, restaurants – and a welcome from the Oslo Hotel, our next residence.

Reported by David Ward

Coimbra

Approximate locations of sites.



Monday 29 September - Figueira da Foz and Cimpor Cementos de Portugal,Cabo Mondego.

9.00 am Left Hotel Oslo, Coimbra driving West along the Mondego river, which looked peaceful, towards the boundary of Jurassic and Cretaceous with Palaeozoic rocks. The area is faulted with slight dipping to the South: which happened during the Hercynian period. We drove through a cutting in the road which was an anti-cline structure of Jurassic sand and terracotta soils and which showed the older rocks overlying the younger rocks, we passed several small works extracting sand and the terracotta clay.
The vegetation was mostly wooded with salt marshes and rice fields on the flatter valley nearer the coast.

Figueira da Foz

This small town had once been an important fishing area, but now it depends mostly on tourism, and the small fishing houses have been sold for holiday people. There is also a hillside fort which had been captured by French students during the 1800's and which had been used by Wellington and his troops before their travels South.
We arrived at the wide expanse of beach; the tide was out and did not hinder our exploration. We examined the lithologies of the Upper Jurassic and Cretaceous. The sedimentary sequence is from Marine Jurassic to continental Cretaceous from South to North.
The Limestone had a lumpy appearance, and the Sandstone had coarse to fine pebbles deposited, we assumed this was a shallow marine environment with river drainage. During flooding the particles deposited were larger than during quiet times.

There appeared to be a history of shallow seas - limestone;
slight erosion and run off from the land - sandstone;
storms- pebbles;
and quiet periods - small pebbles.
In England these sequences are called cyclotherms and are repeated depositions. We noticed the mica in the sandstone; which possibly proved it had been deposited in a marine environment. If

the sandstone had been devoid of mica it would have shown the sand was wind-blown, the wind having blown the mica away.

Cimpor Cementos de Portugal,Cabo Mondego

At Cimpor Cementos de Portugal,Cabo Mondego we were shown around the Lower Jurassic Limestone Quarry at the North end of the beach. It was explained how granules of ammonum nitrate and diesel oil are placed in drilled holes several metres apart, and the side of the cliff blasted off. It depended on how much material is needed as to how often this operation takes place. Up to 700 thousand tonnes are quarried in a year.
The material is collected, crushed and heated, there is sufficient clay within the quarry to make the cement, although the main product sold is bagged lime.
We then spent time looking for finds in the limestone, such as belamite casts, ammonites, slicken slides and pyrite.

Reported by Irene Davison

Monday 29 September p.m
Luso

Following a pleasant lunch at a Figueira da Foz beach café we headed north east, away from the coastal plain, to the uplands and the older rocks; the source of the sedimentary rock deposits we had examined on the beach in the morning. We noted the rice being harvested in the paddies in the Rio Mondego valley; also the Terra Rosa soils formed on the limestone hills.

The coastal plain is separated from the upland areas by a series of approximately NNW faults between Mealhada and Luso. The uplands comprise of a thick series of deposits laid down during Pre-Cambrian, Cambrian, Ordovician and Silurian times. Granites were intruded about 300 M years ago. There has been some mineralization and gold was worked during Roman times. Luso is well known for its spring waters and thermal baths.

Luso is situated at the northern end of the Serra de Buçaco, a NW-SE syncline structure. The main period of folding was during the Devonian. Our driver dropped us off at Cruz Alta, the highest point, where we had wonderful views of the surrounding countryside. Being a syncline the youngest rocks, Silurian (schist-metamorphosed mudstones) are at the centre, with Ordovician rocks to the side and further out Cambrian. The Ordovician contains large amounts of hard quartzite (metamorphosed sandstone) which protects the softer Silurian rocks. There are numerous faults and we observed breccia rocks in one of the faults near the top of the hill.

View looking north from Cruz Alta; high ground is formed from Ordovician quartzite.

Breccia from fault zone near Cruz Alta

We then walked down a series of paths to Buçaco. The buildings, of great architectural quality, are set in magnificent landscaped surroundings. The convent, chapels and hermitages were built between 1620 and 1700 by the Catholic order of the Barefoot Carmelites, who also created the paths and trails and began the plantation of the woodland reserve. The Grand Hotel was built at the end of the 19th and beginning of the 20th Centuries. We examined a small schist deposit behind the hotel but it was too weathered to reveal anything of interest.

Grand Hotel, Buçaco

We had arranged to meet the bus at the hotel, but it did not arrive! An hour later and after numerous failed attempts to contact the driver by phone a search party was sent out, while the rest of us enjoyed the beautiful surroundings and ice creams. After 20 minutes the search party returned having located the bus at an entrance to the hotel-the guard would not let him in unless he paid a large entrance fee!

Reported by D. Riley.

Tuesday 29 September Geological museum Coimbra

While the Group visited the mine at Panasqueira, Louise visited the Geological Museum at Coimbra University. I was lucky to be let in for free (Entrance charge is 1.5 Euros)

In the foyer was a beautiful fossilized tree trunk approx 50 cm in width (Source unknown)

The museum contained a large collection of minerals from all over the world, and 2 side-rooms of rocks and minerals from Portugal.

The first side-room was organised by rock type, from 'Rochas Metamorphicas Peliticas' through 'Sedimentares Vulcaniclasticas' to 'Bioquimicas'. Each rock-type had a map of Portugal with the distribution, and uses of many minerals were demonstrated e.g. a Gauntlet made of Silver, and a Lightbulb and Miniature tank next to the specimen of Volframite.
Unfortunately the lights in the sedimentary section did not work, but since I was more interested in the Igneous section I was not devastated!
The lit-up section also included regional displays from Madeira and the Azores fuelling excitement about possible future field-trips!?

The second side-room included a display of minerals organised by Portuguese Region. This included a case of rocks and minerals from Panasqueira including :

1. Arsenopyrite.
2. Marcassite.
3. Quartz,
4. Quartz and Siderite.
5. Dolomite (? with flecks of pyrite)
6. Cassiterite.
7. Apatite.
8. Siderite and Blenda.
9. Siderite and Apatite.
10. Arsenopyrite.

In addition I visited the Zoological Museum (Entrance Charge 4 Euros, but well worth a look.) Of particular interest to Geologists were a beautiful collection of shells with sound effects of breaking waves! The fish section was not lit-up! (to save energy!) but the curator confessed many of the fish were incorrectly labelled and needed updating! There was also a display of approx 20 different

types of Deer in a group as if grazing together in Savannah-like terrain, and a beautiful polished Turtle.

Reported by Louise Knight

Tuesday 30th Sept 08 – Tin-Tungsten mine at Panasqueira.

The plan for Wednesday was to visit the Tin-Tungsten mine at Panasqueira, about 100km east of Coimbra. As every day of this visit, we had perfect blue sky, temperatures in the mid 20's and occasionally a gentle breeze.

The route to Panesqueira is along winding roads – the K6 and N 17 - which follow the valley bottoms in a landscape which is composed of sharp ridges and deep valleys, mainly covered with pine and, increasingly, eucalyptus: the result of both deliberate planting and the eucalyptus's ability to colonise wherever it has the opportunity. Many small but interesting villages were viewed, as were the tight and sometimes almost blind bends – but Paulo our driver was a match for them.

The roadside geology changed rapidly at first – outcrops of limestone and a cement works close to Coimbra indicated that we were on the coastal plain side of the major fault which divides Palaeozoics on the east from Jurassic and Triassic on the plain and which passes just to the east of Coimbra.

Shortly we travelled onto distorted reddish brown rocks, which were the metamorphosed Silurian sediments and on the highest ground we sometimes could see white outcrops of Ordovician quartzite.

A few kilometres short of the mine, we stopped in the town of Pampilhosa da Serra to use the facilities. In the town square is a fountain with a statue of a man holding a suitcase and looking a little depressed – some debate followed as to whether he was the discoverer of the mine, a local dignitary concerned about the pollution, or possibly a World Memorial to travelling salesmen.

Panesqueira Mine is visible from considerable distances because of its immense tips – grey and golden brown, both at the mine itself and at the former processing plant on an adjoining hillside.

We arrived at Cabeco do Piao, the former processing site. Aerial ropeways brought ore here from the mine and some of the pylons and cables were still in place.

The processing site had been derelict on Lesley's last visit, but was now being painted up and more equipment installed – we were told that it was to become a museum, but the scale of development and its remoteness from passing traffic made this seem rather unlikely.

Mine dumps – flowing down the hillside and probably into the River Zezere – were examined by the eagle-eyed RGS and an interesting range of minerals identified. These included pyrite, tourmaline, quartz, arsenopyrite and malachite, on both granite and metamorphic country rocks.

After attempts to speak to various workers regarding the development, we moved on to the next site.

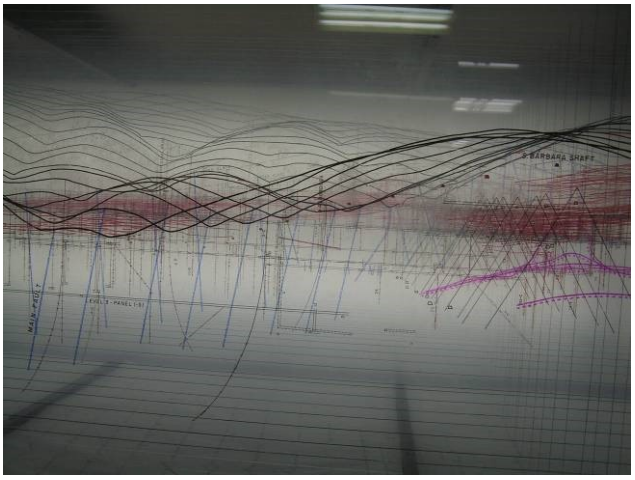
This was a viewing point above the mine itself, where there was a large memorial to the miners, some underground mining machinery, facilities (closed!) and a collection of rather nice, large boulders of mineralised rock.

There were also seats out of the sun, where we enjoyed our lunches. Directly below this point was the main mine buildings – a mass of conveyers, buildings, processing plant and the current waste dump. This was impressive – a flat top the size of many football pitches, being extended both horizontally and vertically and in places accommodating part of the process structures.

Lesley explained that the tin and tungsten mineralisations occurred separately. The tin was hosted in pegmatites in the granites, while the tungsten is carried in veins and metamorphic skarns. The age of the deposits covers an interesting time span – Precambrian to Silurian (but this may refer to the entire metalliferous province, which extends over NE Portugal and NW Spain)

The mine operates through adits rather than shafts and pillar-and-stall working is used to remove the ore.

Our next stop was the Mine Offices, which as usual had extremely interesting geological sections, maps and three-dimensional models of the underground structures and workings, closely examined by the members.



Some negotiation by Lesley resulted in us being ushered to the first floor, where a door was opened and many RGS jaws dropped. A large room had been given over to mineral specimens collected from the mine, put on show and were for sale. The party swept in and began a meticulous examination of the goodies. These ranged from 10 cm tall quartz crystals (10 €) to 50 cm beasts (400 €), with exquisite specimens of cassiterite, wolfram and the copper and arsenic minerals, both as single minerals and as clusters of many minerals together. Needless to say, this sorting was a fairly slow business of one balancing euros against weight of baggage on the plane against personal preference.

Amusingly, we think for VAT reasons, details of the purchasers were needed together with identification – and everything became related to DR Ward's passport, the document first offered.

We left, with some considerable reluctance, for the journey back to Coimbra.

Our route took us over the hills to the NW of the mine and as we climbed higher, the structure of the area became clearer.

Lesley pointed out rounded hills – the Hercynian granites - with in places long ridges of bare white quartzite, the Ordovician rocks, apparently faulted against the granites.

An uneventful return journey saw us back in Coimbra in good time, ready for a shower, dinner, a little drink and of course discussion of the days geology.

Reported by DRWard

Wednesday 1st October a.m

Chas da tavare

Today was the first overcast day of our trip and we were a little apprehensive that we might have to unload our waterproofs for the first time. We began the day travelling north on the coastal plain as before, turning east and then north east around Santa Comba Dao on to the Hercynian Granites. These huge intrusions of granite continue all the way to the Spanish border.

As we travelled north east we could see the Sierra Da Estrela range of hills off to our right in the distance. There were many granite outcrops along the road, little vegetation apart from scrub and broom, and the only cultivation was in the river valleys. We observed that the local population were making good use of available resources, using the granites for fence posts and vine supports.

We passed the old Urgeirica uranium mine and processing plant near the town of Nelas. The mine operated from 1951 until 1991. Decommissioning was to have begun in 2005 but was delayed. Reclamation of the site was due to start in 2006 –07. I have been unable to establish whether this has been completed.

We finally arrived at our first stop for the day at the Chas Da Tavare quarry and the sun had finally come out. This is a small quarry still being worked. We arrived en mass to the surprise of the workers on the far side of the quarry, who proceeded to ignore us and carry on with their business.

The granites in the quarry are very degraded and consequently soft enough to be dug out with diggers. On examination the main body of the granite consisted of a coarse grained, grey clearish quartz, white alkali feldspar, mica and tourmaline. The granites were very fractured and contained a number of interesting pegmatites. The pink we could see in the rocks was caused by lithium which was taken up by mica to produce lepidolite. The granites were intruded between the late Carboniferous and Lower Permian about 300mya.

After a short description and explanation of the geology by Leslie we proceeded to examine and collect. We were very excited to find a wide variety of minerals particularly around the fracture

zones. One pegmatite seen higher up on the side of the quarry displayed large quartz and micaAfter a short description and explanation of the geology by Leslie we proceeded to examine and collect. We were very excited to find a wide variety of minerals particularly around the fracture zones. One pegmatite seen higher up on the side of the quarry displayed large quartz and mica.

Wednesday 1st Oct p.m.
Mesquitela

Portugal is amazingly rich in lithium bearing rocks, mainly in aplite-pegmatite veins, rich in the mica lepidolite. These are in the late Hercynian granites in the Guarda region. Cassiterite, tantalite and beryl also occur.

The mine is in a most unlikely setting, on what appears to be the edge of a cliff. The mine is worked out so the site is now used as a crushing area for lithium rich rocks brought in from Guarda area.

A wait for the owner, Alexandra Carolina, gave us time to forage for good samples of feldspars and micas from the stockpiles. The mine was originally a cave with mineral veins in grounds which belonged to Alexandra's grandfather, a far-sighted farmer. He worked the mine (originally feldspar for china) and gradually bought up the surrounding land. The First World War brought tungsten to the fore as a valuable mineral for armaments, the ore being sold to either side. The mine was worked out and is now being revamped as a possible tourist attraction.

It was an 'exciting' tour.
The way down to the mine entrance in the cliff was a spiral stairway, maximum of three people at one time, overhead hung the old bucket on a gantry.
Rucksacks were left at the top of the stairs.

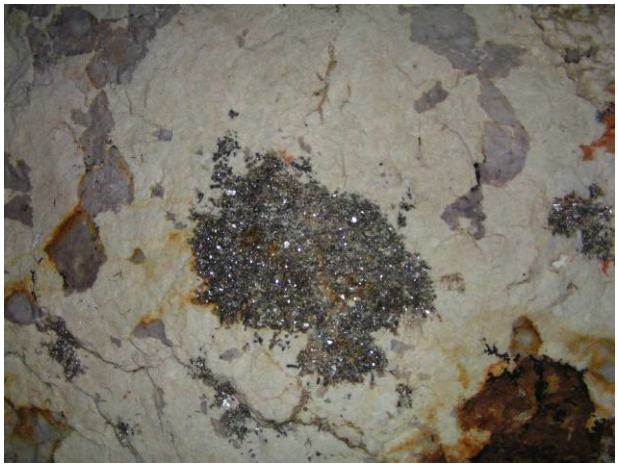
Hard hats were provided.

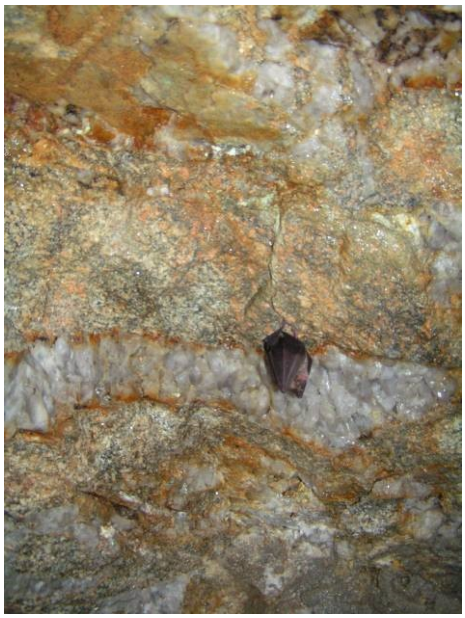
The mine floor itself was level, seating provided and even proto-toilets. Patches of the minerals once mined have been left exposed, we saw greenish beryl crystals 5cm across and large feldspars. Alexandra explained the mine would have educational sound and visual displays in the main area, shown in the photo.

The stone plinths would hold quartz crystal specimens that were found in a different mine. These are presently kept in their garden.

Malachite

Cassiterite





Feldspar crystals and bat.

As we went deeper into the mine the tunnels became narrower and a home for bats. The shafts, dug for ventilation, provide a flight exit for the colony.
It is hoped that the colony will survive any alterations to their present home.

Alexandra invited us back to her house and garden to see the quartz crystals. It was a short walk from the mine through pine woods into her garden.

We were staggered by the number and size of the quartz crystals. They were found within a natural cavity in the granite as the miners followed the veins. It must have been huge, Alexandra described it as a cavern, that was full of enormous crystal forms. As the miners started to remove the crystals the cavern became unstable and it finally collapsed. What we saw was the best they had brought out.

These ‘rocks’ are single quartz crystals.

Reported by Christine Hooper.

Thursday 2nd October

Peniche

We left Coimbra with very heavy luggage which poor Paolo had to lift into the boot. I chose a large specimen of Lepidolite (2 Kg) in preference to a bottle of white Port! A heavy mist hung over the river so the old town with its terracotta roofs was hardly visible. Long discussions between CG and CF ensued concerning the definitions of epidote versus peridot.(epidote- Ca, Al, Fe silicate; peridot – olivine includes Mg, Fe silicate). It appeared that several people had discarded specimens of epidote in their wastebins thinking it to be of little value…poor chambermaids!

We then journeyed south over mainly Miocene sands and gravels with hilly regions formed by Jurassic and Cretaceous. Further south we passed over a thin strip of Cretaceous followed by Jurassic for most of the rest of the journey. This region comprises an anticline structure with flat lying Jurassic forming the core of the anticline. This is made up of mainly upper Jurassic with some middle Jurassic (Oxfordian and Kimmeridgean).

Our **first stop** was at **Peniche**, originally a small fishing village, now a large holiday resort. Many signposts displayed pictures of dinosaurs signifying that we had arrived at Portugal's Dinosaurland.

Paolo parked the coach off-piste at Cabo Carvoeiro. Here there were strange formations of 'Pancake Rocks'; stacks of layered lower part of middle Jurassic and upper part of Lower Jurassic. On these we were delighted to find constellations of star shaped crinoid ossicles (pentacrinites) and sections of crinoid stems with max. 10 ossicles. and crinoid arms. No-one found calyces (plural of calyx?) …must try harder next time ! Carol, however, found a related large Echinoid approx 2 cms across.

Leslie informed us that Crinoids usually anchor in quiet protected seas on rocks or wood.

CF then lured poor Leslie into an awkward crevice to examine a sequence of units with coarse grained Jurassic containing crinoids at the base including some Jurassic sandstone, topped by fine grained bedded silts with bioturbation. These represented deeper water followed by quieter shallower seas, probably at the Toracian-Aalenian boundary, same as at the cement quarry.

After a blowy cliff top lunch sitting on pancake stacks, DW spent the remaining time looking for crinoid 'stars' for his granddaughter.

Stop Two: Lourinha Museum:

Unfortunately this visit was curtailed by a communication failure, probably caused by jetlag, as the museum curator, Octavio Mateus, had just returned from a fossiliferous destination in Argentina. We therefore had a hurried tour of a fascinating museum, narrowly avoiding a band of noisy Portuguese schoolchildren doing the same tour in reverse!

First we saw historical agricultural machinery that was still being used 50 years ago such as sprayers and ploughs. Octavio showed us containers used by his grandfather for selling oil and soap.

We then moved outside to see an excellent collection of dinosaur track casts including sauropod footprint +nail, sauropod with striations of skin on sole and stegosaurus which are fairly rare.

20 species of dinosaur have been collected in Portugal in a fairly small area from Capo Mondego to Espichel.

We then moved inside to the conservation room where work was in progress to conserve Dinosaur eggs, a sauropod scapula and humerus from Angola, Turtles, Mammals and Ammonites.

The National Geographic is funding a lot of their work.

Upstairs we saw a dinosaur, Dacentrus armatus, with 17 vertebrae in its neck, the most ever found in a Chinese specimen of Mamenchisaurus. There was a Camarasaurus 16 m long and 4 m high, with very long metacarpals, a Dinheirosaurus with hollow vertebrae, a characteristic later exploited by birds to enable flight. Other characteristics already developed in dinosaurs and exploited by birds include feathers and a 4-chambered heart.

The highlight of the upstairs gallery was a cross-section of dinosaur eggs with embryos inside.
This is the only such specimen to have been found worldwide.

There was also a specimen of the pterapod Lourinhosaurus antunesi which is the first to have been found with gastrolites, used to grind food in the stomach.


Lourinhanosaurus embryo model

Drawing of egg and vertebra of baby.

Nest

Deinonidius

Contact Museu da Lourinha www.museullourinha.org.

Reported by Louise Knight

Afterthoughts
from Christine Hooper.

Gastronomic

I don't like fish. But Portugal is a fishing nation; the fish will be fresh and non-smelly, especially in Setubal - which comes with restaurants on the quayside - so I ate fish. I am now converted to swordfish, but not salted cod (which is a staple part of the Portuguese diet) or sardines - equally salted. But then, I don't like fish!

Others found the fish restaurants great - especially *Poco das Fountainhas*, Setubal - where the chosen piece of fish was weighed and priced accordingly. You could even choose a live fish to be killed and cooked for you.

O Carloto Restaurante, Cascais – the planned picnic turned into a full-blown restaurant stop (a little restaurant the driver knew!). The Portuguese eat their main meal at lunch times and our requests for salads was met by mine host (he spoke very good English) with surprise, 'were we vegetarians?' The melon was the sweetest and most beautifully prepared I have eaten. Wine was drunk and the lunch break extended to a length previously unknown.

Coimbra (a University city), should have, and probably does have, lots of nice restaurants. A short walk across the road from the Hotel, we found *Calado and Calado*. A small, family restaurant, rather bistro-ish but catered easily for ten people turning up at the same time. We chose this for the last meal (a treat in more ways than one) so it must have been good.

We did try other restaurants but these are the one's that were outstanding.

In Setubal, conveniently in front of the Esparance Centro Hotel, there was what became the 'pub on the island', the first stop after a hot day.

Portuguese menu explained.

Carne de Porcoa – pork and potatoes diced, small pieces of cauliflower and olives all cooked in tomato sauce. Verdict - good.

Patamoscas ci Arras – cod fritters with savoury rice.
Iscas – liver
Bacalhau – salted cod, comes in many disguises.
Choquinhos – a tiny squid – rather tasty
Esparte – swordfish, a nice, solid, boneless fish - see above.
Sardinhas assadas – grilled sardines. Usually with sea salt coating - accompanied by strong smell of smoke from the grill.

Pastelaria – cakes and pastry shop or café.
Pudim – pudding, a sort of custard tart flavoured with Baileys Irish Cream.
Vinho de casa – guess!
Vino verde – a very young but drinkable wine.

Green or otherwise.

Cork oaks, we didn't see many of these! Oaks are stripped of their bark every nine years to a height of 6 or 7 feet. The year is painted onto the raw tree for the records.
There are, however, lots of eucalyptus, these were introduced for fuel and have taken over the slower- growing pine woods.

The pink flamingos on the salt- pans at the edge of the Teho estuary.

Swimming breaks, only two brave souls tried the sea – and they regretted it!
(No, not at all! DRW)

The Bikers meeting at Cabo da Roca – lots of noisy, shiny motorbikes.

Indentifying Granite for Dummies

Feldspar	-	white and formless
Quartz	-	crystal
Mica	-	glints flat plate-like
Tourmaline	-	black no shine
Lepidolite	-	pink mica, mineral –lithium
Garnets	-	dark red
Autonite	-	bright fluorescent green uranium mineral.