

Morocco Fieldguide 2008



Jurassic reefs in the Atlas Mountains



Devonian fossils near Erfoud



Dunes near Merzouga

**SCHOOL OF EARTH SCIENCES
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Morocco Field Trip Guide

GEOLOGY OF MOROCCO

The geology of Morocco is extremely varied, and preserves an almost complete geological record from the Archaean to the Recent. The Pre-Cambrian and Palaeozoic geology records a number of orogenic events, and the gradual movement of the African Plate from a position near the South Pole in the Ordovician to the tropics by the Carboniferous. This terminated in a Carboniferous-Permian phase of deformation very similar to the Hercynian/Variscan deformation of Europe (although on a separate continent at the time). In the period between the Permian breakup of Pangaea and the Alpine deformation of the Tertiary, Morocco was on the southern margin of the Tethys Ocean and hence separated from Europe by a narrow but significant ocean. During the Triassic and Early Jurassic, there was North-South extension forming sedimentary basins within which were deposited the rocks that now form the Atlas Mountains. At the same time, there was very major East-West extension related to Atlantic rifting in the area that is now offshore to the West of Morocco, and by the Jurassic this had allowed oceanic crust development along what would become the North Atlantic. The partial closure of Tethys (leaving the Mediterranean) during the Tertiary caused a major phase of mountain building, and resulted in the deformation within the Rif and Atlas ranges. Quaternary climate changes resulted in a fluctuation between very arid and quite humid conditions; at present the Atlas range marks the northern limit of the Sahara, and desert erosional and sedimentological processes dominate much of inland Morocco.

Moroccan geological regions

Morocco can be divided up into a number of different geological regions, each characterised by a different geological history. On this field class we will be crossing the western and eastern Meseta, Atlas Mountains and eastern anti-Atlas (see below).

The Rif

The Rif is a region of northeastern Morocco dominated by Mesozoic and Cenozoic sedimentary rocks that have been thrust southwards during the Alpine Orogeny. This is very similar to the geology of parts of southern Spain and is partly continuous with it. The reason that this region and Spain are separated by sea rather than high mountains is thought to be due to detachment and collapse of lithosphere and subsequent isostatic subsidence.

The Mesetian

This comprises deformed Palaeozoic and Pre-Cambrian rocks with a partial thin cover of rocks of Cretaceous to Recent age, which are essentially undeformed. This is found in two main regions: the northern coastal plain (Western Meseta) and a block separating the Middle and High Atlas in the East (Eastern Meseta).

The Western Meseta covers the area between the Mediterranean or Rif and the Atlas range. It typically forms flat land with few exposures. The pre-Mesozoic basement is partly covered by thin Cretaceous and Tertiary marine carbonates which were deposited along the Tethyan margin. Upwelling in the latest Cretaceous to Eocene allowed the deposition of phosphorites. These are condensed deposits dominated by oolitic or bone fragment phosphates, and are by far the most important economical deposit in Morocco, comprising 65-75% of world phosphate reserves and providing over half the nation's income.

The Eastern Meseta forms a stable plateau with fold belts of the Atlas to the South and North. This forms the geology of the region around Midelt, where the dominant geology is granitic and metamorphic basement, in places containing import reserves of vanadium, lead and other minerals.

The Atlas

The Atlas range is formed of a foldbelt of Alpine age that forms a Southwest-Northeast trend. Deformation is typically in the form of large scale thrusts and box folding, very similar to that seen in the external areas (such as the Jura) of the European Alps. There is little or no metamorphism associated with this deformation. In places, there are large areas of Palaeozoic basement rocks incorporated into the Atlas structures, but in the east of the country, where we are going to be, exposed rocks are almost entirely Mesozoic. In the east of Morocco, the Atlas can be divided into the more northern Middle Atlas and the more southern High (Haut) Atlas, separated by the stable block of the Eastern Meseta.

The Middle Atlas typically comprises massive Mesozoic to Tertiary carbonates, although black shales with phosphates are present in the uppermost Cretaceous in places. The limestones are commonly either forested or highly karstified, and the underlying geology is not often clear. In one region, there are relatively extensive Pleistocene basaltic volcanics. These comprise a number of small cinder or lava cones, and extensive flows of vesicular lava, commonly seen infilling palaeovalleys.

Although the High Atlas contains considerable areas of non-marine Triassic rocks and underlying Palaeozoic basement in the West of Morocco, to the East the rocks exposed are dominantly Jurassic. In this area, two distinct facies belts are present, separated by a major thrust that marks the position of a reactivated normal growth fault. To the North of this divide, Lower Jurassic rocks are well exposed. Away from the southern edge of the belt, they are typically hemipelagic or pelagic carbonates. These preserve very clear cyclicity on a variety of scales, and this is likely to be due to orbital forcing. Closer to the basin margin, these pass into carbonate turbidites. In places, especially close to the basin margin, patch reefs are present. These are formed largely of sponges and so may have formed in deep water. There is a general shallowing upwards, and Middle Jurassic rocks comprise open shelf limestones, with patch reefs being very common at some levels. In the late Middle Jurassic to Early Cretaceous, further shallowing resulted in non-marine sedimentation. To the South of the basin margin fault, Middle Jurassic rocks are typically in intertidal to peritidal facies, with non-marine red beds being present, although there are some patch reefs within some of the older Middle Jurassic rocks.

The Anti-Atlas and Saharian

To the South of the Atlas Mountains, weakly deformed Palaeozoic and Proterozoic rocks dominate, with a thin cover of Cretaceous and Tertiary in places. The southern edge of the Atlas range marks the limit of Jurassic sedimentation, and to the south of this Triassic and Jurassic rocks are largely absent. The Anti-Atlas comprises an area of gently folded and faulted rocks of Carboniferous age and older that was deformed during the Hercynian/Variscan phase. To the west these rocks form a range of mountains that parallel the Atlas, but in the East the land is of low relief. Further South-East these rocks are unexposed, being below Cretaceous and Quaternary deposits, but the deformation becomes weaker as the rocks overlap the stable Archaean craton that underlies much of North Africa.

In the western Anti-Atlas, there are outcrops with continuously exposed sections extending from the Proterozoic into the Cambrian (there are few of these globally), but in the East these are not seen because Proterozoic rocks are largely granitic. Cambrian and Ordovician rocks are dominantly open marine mudstones and sandstones. These were deposited in cool waters close to the South pole, but still contain common fossils; many of the Cambrian trilobites are genera also found in England and Wales, suggesting that Avalonia and what is now North Africa were quite close. The ice sheets of the end Ordovician glaciation covered much of what is now North Africa, and their northern edge reached Morocco; glaciogenic features such as tillites and iceberg grounding marks are present in western Morocco, but in the East only shallow marine sediments are seen, suggesting that the ice margin lay between these areas.

Silurian rocks are largely absent, but latest Silurian pelagic limestones containing fossil nautiloids are the basis of a local decorative stone industry near Erfoud. Devonian rocks are far more extensive, and are dominated by carbonates, with bioclastic limestones in the Lower Devonian

passing upwards into deep water pelagic limestones and shales in the Upper Devonian. In places, conical and irregular-shaped carbonate build-ups are present. Although some are present in the Middle and Upper Devonian, they are most extensive in the Lower Devonian. Spectacular reef-like structures, probably classifiable as mudmounts, contain relatively few fossils other than low diversity corals and 'tube worms'. The fauna, sedimentology and geochemistry of these suggest that they may have formed around methane seeps or undersea hot springs, and it is possible that they may be related to nearby high level basaltic intrusions. Carboniferous rocks are less well exposed, but are dominated by shales, which, like in the Devonian, contain large numbers of conical mud mounds.

Around the margins of the Anti-Atlas, the Proterozoic and Palaeozoic basement rocks are unconformably overlain by Upper Cretaceous rocks. The lower part of the Cretaceous succession comprises fluvial sandstones (from which a large number of dinosaur fossils have been collected) which pass upwards into open marine limestones. To the west, small basins containing shallow marine Tertiary deposits are also present.

Quaternary non-marine sedimentation

Extensive deposits of Quaternary sediments are present across a lot of Morocco. In the North, these are dominated by alluvial fans coming off the Atlas Mountains, and fluvial deposits. Further South, desert conditions have allowed the deposition of a range of facies, especially alluvial fans, desert floor braidplains (giving rise to the 'stony desert') and aeolian sand dunes. Aeolian dunes are far less extensive in Morocco than elsewhere in North Africa, but a small erg is present near Merzouga. This is surrounded by escarpments, and so is likely to be influenced by complex wind patterns. Large star dunes are present, with smaller scale dunes both in the erg and elsewhere on the desert plain.

Economic geology

There are two geological materials that are of extreme importance in Morocco; water and phosphate, although in the past there has been considerable mining for various minerals (including vanadium and lead) near Midelt. Morocco has the World's largest reserves of phosphate and is the World's third largest producer of phosphate which is largely used to produce fertiliser. The phosphate deposits are condensed marine phosphorites produced by upwelling along the edge of Tethys during the latest Cretaceous to Eocene, and may be composed of fish bones, ooids or peloids. We will not have a chance to visit any of the main phosphate regions, but we get a chance to see small scale phosphorites.

Morocco also produces barite, zinc, fluorspar and silver, further information can be found in the Mining Review of Africa Issue 4/2004 (www.miningreview.com/archive/mra_4_2004/46_1.php)

Water resources

Northern Morocco has a semi-arid 'Mediterranean' climate with winter rains. There are few rivers, and most are dammed with the water diverted into a series of canals and irrigation channels (especially the traditional *sequias*). There are few good aquifers in the Palaeozoic basement rocks, but Quaternary sediments and Cretaceous limestones are important aquifers in places. In areas close to phosphorite mines, the water is often heavily contaminated by fluorine from the phosphate processing plants, so fluoride poisoning is a very major problem. The Atlas Mountains catch most of the rain going further inland (the northern side is often forested, whilst the southern parts of the range are dry and barren). Although some rain does fall in southern Morocco (mostly in Autumn) and major floods are not unknown, most of the water there is from rain or snow falling in the Atlas and carried south in a small number of rivers. Valley floors are often heavily cultivated in contrast to barren mountains, and when the rivers reach the desert to the south, the water is diverted into canals for irrigation and domestic use. Some of this water is diverted into (often ancient) underground channels that fan out into the desert. These have been essential to life of nomads in the region as the lack of good aquifers means that there are no reliable oases in the region.

The fossil industry

Southern Morocco has traditionally been very poor, and the recent establishment of a cottage industry based around fossils and decorative stone has been very important to the area. There are

4 main areas in Morocco where fossils and minerals are collected for sale. 1. Near Agadir in the West relatively large Cretaceous ammonites are collected. This is the least important of the four. 2. In the phosphate mining areas, especially near the town of Oued Zem, large numbers of vertebrate fossils are collected from the mines, often by the mine workers. Shark teeth are collected in vast numbers, but the most valuable fossils are of mosasaurs and other Cretaceous reptiles. 3. The area around Midelt was once important for mining of a range of minerals. Although the mines have largely closed, there is considerable collection and small scale mining for mineral specimens, especially vanadinite. 4. The largest and most diverse industry is around Erfoud. The main traded materials here are trilobites and cephalopod limestones. Trilobites are mostly from the Middle Devonian but also from the Cambrian and Ordovician. They range from small and crudely prepared specimens to amazing spiny forms that are painstakingly prepared; these can retail for over US\$3000. There are also huge numbers of 'improved' specimens and fakes, some of the latter are very convincing (others not) and a very large percentage of Moroccan trilobites are likely to be faked. Silurian black limestones with orthocone nautiloids and Upper Devonian reddish limestones with orthocones and ammonoids are quarried in large quantities. These are either cut and polished as decorative stone objects (from ash trays to toilets), or individual fossils are polished for sale. Other items sold in large quantities here include specimens of the large crinoid *Scyphocrinus*, Ordovician echinoderms, dinosaur and fish fossils from the fluvial Cretaceous, ammonites and whole fish from the marine Cretaceous and meteorites (mostly NWA chondrites) collected in the dunes.

GENERAL ITINERARY

This will give a very general idea of the areas that will be visiting on the fieldclass, but this may change. Coordinates have been included so that it is possible to look at the areas mentioned on Google Earth (many of the geological features are very clear on satellite imagery).

March 19th. Fly into Marrakech (31°40'35"N, 8° 1'51"W) This is on the flat land of the Western Meseta, although the Atlas Mountains are very clearly seen to the South. We will drive North East to Midelt (32°40'45"N, 4°44'20"W).

March 20th. Drive North across the Eastern Meseta into the Middle Atlas. Around 33°20'51"N, 5° 8'28"W there are large basalt flows and cones. The lavas are clear on Google Earth as brown areas against the pale limestones. There are cones seen, some covered with forest. We may have a chance to look at a phosphate deposit nearby.

March 21st-22nd. Drive south across the Atlas Mountains, staying in a hotel part way. The northern belt of the High Atlas is seen between 32°35'26"N, 4°30'16"W and 32° 9'59"N, 4°22'18"W, and the southern belt between there and 31°58'35"N, 4°27'41"W. South of this the Ziz Gorge cuts through near horizontal Cretaceous rocks until the unconformity with the Palaeozoic is reached at 31°30'17"N, 4°11'25"W. We will stay on the edge of the erg at Merzouga (31° 6'35"N, 4° 0'2"W) for the rest of the time.

23rd-28th March. We will be working in the Anti-Atlas around the Erfoud-Merzouga area. This will include geophysical and topographic surveys of the dunes and other modern sediments, study and mapping of Devonian mudmounds around 31°22'36"N, 4° 3'7"W, study of local water resources and observation of the fossil industry in the field and at Rissani (31°17'32"N, 4°16'17"W). We also plan to study other Palaeozoic and Cretaceous sections, but these have not been finalised.

29th March. Drive back to Marrakech, overnight there and fly back to London on the 30th of March.

ASSESSMENT

This is an advanced fieldclass, and so the assessments will often be challenging and test a range of both theoretical and field skills. You will learn and practice a range of advanced field skills, and be able to observe geological phenomena that you will not have encountered on previous fieldclasses. A number of separate pieces of work will be assessed, each taking between half and two days of fieldwork to complete, with different pieces of work carrying different weightings towards the final mark. Where possible and practical, work will be assessed during the fieldclass to allow rapid feedback. Although some of the assessed work will be written directly into your field notebook, the notebook as a whole will not be assessed. It is, however, essential that you keep good notebook records even for work assessed by other means, as some of the assessments will require you to use records from your notebook to construct a summary answer. The course is

designed to assess fieldwork, although different pieces of work will require different amounts of work in the evenings to complete. In some cases evening work may simply be a case of inking work in, at other times more extensive data processing will be required.

ADVICE TO STUDENTS ON GEOLOGICAL FIELDWORK SAFETY AND BEHAVIOUR

[Issued by the Committee of Heads of University Geology Departments]

A. SAFETY

I. To: All students attending geological field courses

Geological fieldwork is an activity involving some inherent special risks and hazards, e.g. in coast exposures, quarries, mines, river-sections, and mountains. Severe or dangerous weather conditions may also be encountered at any season, especially on mountains or the coast.

In accordance with the Health & Safety at Work act, leaders will have been advised by their Department to follow certain safety precautions and to take every reasonable care concerning the safety of members of their parties. However, the potential dangers make it imperative that students should cooperate by behaving responsibly in order to reduce the risks of accidents. Each individual is responsible for his or her own safety.

You are specifically asked to:

1. Observe all safety instructions given by party leaders or supervisors. Anyone not conforming to the standards required may be dismissed from the field course.

Stay with the party, except by clear arrangement with the leaders. Assemble where requested (e.g. outside a quarry) in order to receive specific instructions regarding likely hazards.

Observe instructions for reporting after completion of work.

Report any injury or illness.

2. Wear adequate clothing and footwear for the type of weather and terrain likely to be encountered. Shirt, loose-fitting trousers, warm sweater, brightly-coloured anorak with hood, are normally desirable in the UK. A woollen hat (in addition to the hood of the anorak) is useful in winter or on high ground. Cagoule and waterproof over-trousers are desirable for wet weather. Jeans are generally unsuitable because they don't give sufficient protection when wet and are subjected to a cold wind, but can be alright if waterproof over-trousers are also worn.

Walking boots with rubber mountaineering soles are normally essential. Sports shoes are unsuitable for mountains, quarries and rough country. Wellingtons are best reserved for walking through shallow water, peat bogs and the like.

Leaders may be advised by their Departments to refuse to allow ill-equipped students on their field courses, since they have a responsibility to see that students observe the provisions regarding personal safety.

3. Wear a safety helmet (preferably with chin strap) when visiting old quarries, cliffs, scree slopes, etc., or wherever there is a risk from falling objects. It is obligatory to do so when visiting working quarries, mines and building site.

4. Wear safety goggles (or safety glasses with plastic lenses) for protection against flying splinters when hammering or chiselling rocks.

Don't use one geological hammer as a chisel and hammer with another; use only a soft steel chisel.

Avoid hammering near another person or looking towards another person hammering.

5. Take special care near the edges of cliffs and quarries or any other steep or sheer faces, particularly in gusting winds.

Ensure that rocks above are safe before venturing below. Quarries with rock faces loosened by explosives are especially dangerous.

Avoid working under an unstable overhang.

Avoid loosening rocks on steep slopes.

Do not work directly above or below another person.

Never roll rocks down slopes or over cliffs for amusement.

Do not run down steep slopes.

Beware of landslides and mudflows occurring on clay cliffs and in claypits, or rockfalls from any cliffs.

6. Avoid touching any machinery or equipment in quarries, mines or building sites. Never pick up explosives or detonators from rock piles; if found, inform the management immediately.

Comply with safety rules, blast warning procedures, and any instructions given by officials.

Keep a sharp look-out for moving vehicles etc.

Beware of sludge lagoons.

7. Do not climb cliffs, rock faces or crags, unless this has been approved as an essential part of the work.

Take great care when walking or climbing over slippery rocks below high water mark on rocky shores.

More accidents to geologists, including fatalities, occur along rocky shorelines than anywhere else.

8. Beware of traffic when examining road cuttings.

Avoid hammering, and do not leave rock debris on the roadway or verges.

Railway cuttings and motorways are not open to geologists, unless special permission has been obtained from the appropriate authorities.

9. Do not enter old mine workings or cave systems unless it has been approved as an essential part of the work. Only do so then by arrangement, with proper lighting and headgear, and never alone. Ensure that someone on the surface knows your location and expected time of return. Be sure to report after returning.

Leaders of parties will follow the general guidance contained in:

A code for Geological Field Work, issued by the Geologists' Association; Mountain Safety - basic precautions, published by Climber & Rambler; Guidelines for visits to quarries - laid down by the British Quarrying and Slag Federation.

SAFETY INFORMATION SPECIFIC TO THIS FIELDCLASS

Heat and sun.

We shall be working under clear skies most of the time, and there will be no shade at some sites. The sun will be intense, and in the South of the area it may be hot. It is essential that a hat or other head covering is worn, with a brimmed hat being best. Clothes that allow you to cover up and are loose should be worn. Sun block on all exposed skin will also be needed. It is essential that enough water is drunk during the day as it is very easy to get dehydrated. It is suggested that you drink little and often, and do not wait until you feel thirsty. Anyone feeling unwell in the field should return to the vehicles. If we judge it is too hot for safe working during the middle of the day, we will change the work pattern so we will start at first light, and return at lunchtime, with maybe a second, short, field session in late afternoon.

Bites and stings.

Despite being in Africa, there are no large, dangerous animals (wild lions became extinct 50 years ago and leopards are extremely rare) but there are a lot of feral dogs and these should not be approached as they may be aggressive and (very rarely) carry rabies. It is too dry for most biting insects in most of the areas we are going, although in the North and mountains there may be some. These are not known to carry diseases that require vaccinations. Desert animals are very good at defending themselves; and many use venom for this, so all should be treated with caution. There are several species of venomous snake, including vipers and cobras, but these are rare and shy. Do not put your hand on a rock ledge without looking, as in the morning it is possible that snakes could be basking there. Far more common are scorpions; shiny black ones and the far more venomous (but still not fatal) small pale ones. These commonly hide in holes and under

rocks. For this reason never put your hand into a hole, and always kick or push loose rocks before picking them up.

Stomach upsets.

As with all travel, you will potentially be exposed to microbes that your body is not resistant to, and the more exotic the location, the more likely this will be (after all, the term 'gippy tummy' comes from the notion that you will get ill when you visit Egypt for the first time), and so precautions should be taken to avoid illness. Be especially careful to keep your hands clean when eating with them (culturally, you should only eat with your right hand, so the left can be used for 'other things'), I (CJU) tend to carry a small bottle of foam hand cleaner just to be sure. Be wary of unbottled water, and food washed in it. Do not share water bottles, as that can spread microbes. It is wise to have some rehydration salts, and (just in case) toilet paper with you.

LOGISTICS

General

The accommodation and transport for this fieldclass has been arranged by Mohamed Segaoui, who will be acting as a guide/translator/fixer for us during the fieldclass. He co-runs Sahara Treasures (<http://www.sahara.ma/>) and has considerable knowledge of the areas. As this fieldclass has been organised through him as an agent, the money that you will have paid up front will cover all accommodation, transport within Morocco and meals. It will not cover flights to Marrakech, alcoholic drinks and spending money.

The fieldclass will take the form of a transect across eastern Morocco, and there will be a lot of travelling involved, especially as the field sites are several hundred km from Marrakech. It is likely that at least some larger luggage will have to go on the roof rack of one of the vehicles, so make sure that main luggage is in a bag or rucksack suitable for that.

There are some days that could be quite arduous due to a combination of climbing on sand dunes and the heat, although it will be possible to make alternative arrangements for students with genuine mobility issues.

Accommodation

We shall be staying at several different places during the course of the fieldclass (see itinerary). Some of the hotels will be of quite high standard (maybe equivalent to 3 star in the UK), others will be more basic (at least one could be classified as very basic, but it is the only place in the area so there was no choice). There is relatively little accommodation available in some of the areas that we will be visiting, and Spring is high season. It will therefore be necessary for all students to share rooms; the lack of rooms available means that no exceptions can be made.

Visas

Visas are not required by nationals of a large number of countries, including Britain, although entry cards must be filled in on landing. Despite this, all students holding non-EU passports must check whether they will need a visa and arrange to obtain a tourist visa (please do not apply for any other sort of visa; 'educational' and 'work' visas have very specific definitions, and what we will be doing will not count as either. For a full breakdown of visa requirements, see <http://www.embassyhomepage.com/>

Money

You are required to pay for the accommodation and transport within Morocco in advance. A cheque for £450 should be paid to Maz Iqbal before the end of November 2007 to reserve your place on this field class.

The currency in Morocco is the Moroccan Dirham. There are currently about 16 dirhams to the pound. Visa and Mastercard are accepted in some of the larger hotels and at banks, but generally

it is best to have cash, and there are few if any cash points in the areas we will be. Money can be changed at the airport or at banks (but bear in mind that there will be very few chances to visit those). All travel, accommodation and meals are pre paid, but you will require money for additional drinks and for spending money. Note it is illegal to take more than a token amount of dirhams out of the country.

Language

The official languages are Arabic and French; despite this French is only spoken widely in larger towns and cities. Most hotels will have some people who speak English and German. Much of the fieldclass will take place in areas where the main spoken language is Berber.

Telephones

Mobile phones work very well in almost all of Morocco (but the charges can be extremely high).

Electricity

Power points are 2 pin as in France and continental Europe.

Weather

The fieldclass will be along a transect from the Mediterranean climate of the North, over the High Atlas mountains to the edge of the Sahara in the South. Temperatures in the North are likely to be in the 20's, although it may be well over 30 in the South. The area around Midelt is high and snow is not uncommon on the mountains; be prepared for the evenings in the Atlas Mountains to be very cool, although at the time of year we are going this may not be the case. Rain is possible in the North, but virtually unknown at the time of year further South.

Clothing

Clothing will be dictated both by the weather (see above) and cultural constraints. Any student dressed in a way we consider inappropriate for either will have to go and change. Although we are not going to be in a very conservative area, showing too much flesh is very rude. For this reason shoulders, thighs, a low neckline and waist should be covered when outside the hotel (this applies to both sexes). For females, and to some extent males, it is best to keep arms and legs covered. Loose fitting cotton or linen clothing is probably the best bet, as this is also cool and will offer protection from the sun.

Food and Drink

Food in Morocco is generally very good, and eating (or sharing food) is a major part of the culture. Most main meals will be based around food cooked in a ceramic tagine. This is generally lamb or chicken and vegetables and is served with bread. Traditionally, this is eaten with your right hand, but cutlery will be available in hotels. Although there is good vegetarian food around (that is what most of the poorer people will eat most of the time), getting it in a hotel may be very difficult (apparently it is considered rude not to serve guests meat!); even a vegetable tagine may well be cooked in meat stock. We can ask hotels for pure vegetarian food, but cannot guarantee it. Sweets are very good and tend to be based around honey and almonds.

We will have packed lunches, but these may be rather monotonous, based around bread, processed cheese and tinned fish, but we will try to get more interesting foods.

Drink.

Tap water is not reliably safe to drink. We will make sure that plenty of bottled water is available. The main drink in Morocco is sweet mint tea. There is usually a bit of ceremony involved, and it is rude not to accept a second cup. It is very refreshing (when made quickly), but locals tend to drink it very intensely boiled and then it is a very acquired taste. Strong (and good) coffee is likely to be available in the mornings. It may be possible to get tea in larger hotels.

Alcohol is available, but not widely so. Some hotels will be licensed, others not. Larger hotels are likely to have wine that can be bought at mealtimes (some Moroccan wines are quite good), and cans of beer are likely to be available at some of them.

Collecting specimens

There will be no need to collect samples, although it is likely that some students may want to keep some specimens they find or buy. A small number of specimens can be transported in hold luggage (rocks can be seen as potential weapons in hand luggage), but the laws covering export of 'cultural material' are very 'flexible' and it is not unknown for customs to confiscate fossils. If people genuinely want to transport larger quantities of specimens back to the UK, this can be arranged (at a cost) via the Segauoui brothers' fossil export business or via a fossil importer CJU knows based in Cambridge.

FIELD EQUIPMENT

Things you will need to bring:

Clothing suitable for the variety of weather possible; it is essential that clothes suitable for hot, desert conditions are brought (see above)

Walking boots (wellingtons and trainers are not suitable)

Sun cream and hat (scarf or other head covering)

Normal field equipment (without all of these items you will not be able to do all of the work required):

Compass clinometer

Hand lens

Hardback note book large enough for reasonable sized diagrams

Hard pencils or propelling pencil. Also a spare pencil.

Good quality mapping pens of 0.2mm nib size AT THE MOST with black ink. Full marks cannot be given for mapping or similar work if poor quality pens make the work difficult to interpret.

Set of coloured pencils

Eraser

Ruler

Protractor

Tape measure of at least 5 metres

Grain size card

Pencil sharpener or pen knife.

Clip board for map

If you already have a portable GPS, please bring it (with spare batteries).

A hammer should not be needed unless you want to collect samples.

REMEMBER THAT HAMMERS, KNIVES ETC. CANNOT BE TAKEN ONTO PLANES IN HAND LUGGAGE.

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