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1. INTRODUCTION

Geological mapping is the process of gathering geological data in the field and adding that to a topographic map to create a geological map of our own. It involves the careful observation of exposures, searching for other clues about the hidden geology, interpretation of these data to create the map and often then writing a report to accompany the map. It can be fun and it will change the way that a student looks at published geological maps and perhaps the science as a whole. A general introduction to geological sciences and courses in Physical and Historical Geology, Mineralogy, Petrology, Structural Geology, Stratigraphy and Sedimentology are required prerequisites.

The main aspects include:

- Introduction to field geological mapping techniques and recording of outcrop information from igneous, metamorphic and sedimentary rocks.
- Geological mapping in the field, using aerial photographs and appropriate field techniques.
- Map preparation and report writing.
- Maintaining field notebooks.
- Field safety.
- Field camp organisation.

The main aims are to provide students with the skills necessary for constructing and producing geological maps from independent field observations, and training in a range of techniques relevant to conducting independent, field-based, geological projects. The field class also gives insight into the geological history of a part of Nigeria.

Some of the educational goals include:

1. To learn how to construct a geologic map of an area comprising several square kilometers. Students use topographic base maps, aerial photos, GPS units, and compasses to map various suites of igneous, metamorphic and sedimentary rocks.
2. Gaining confidence in making geologic observations and interpretations; broadening of geologic experience beyond the classroom; learning to deal with incomplete or

apparently contradictory geologic data; and learning to cooperate and work in the field with fellow geologists.

3. Students will be able to demonstrate mastery of the concepts and skills acquired during the undergraduate years.

4. Students will learn how to describe and log stratigraphic sequences of sedimentary rocks.

Assessable learning outcomes:

By the end of the course, students should be able to:

- portray on a field map or aerial photograph the location and nature of major geological features
- construct cross sections
- subdivide sequences of strata
- construct interpretative geological maps and diagrams from field maps
- analyse sedimentary facies
- understand and *use selected geophysical equipment to investigate poorly-exposed geological formations*. Some of the relevant geophysical techniques for near-surface investigations include gravity, magnetic, seismic, self-potential, resistivity and induced polarisation, electromagnetic, ground-probing radar, radioactivity, geothermal and geophysical borehole logging. The basic principles and specific areas of applications of these techniques will not be discussed further here (see Sharma, 1997)

Additional outcomes

Students will enhance their presentational skills through assessed results and oral presentations.

This paper describes some of the steps that must go into the planning of a geological field mapping exercise. It has been divided into six sections. Section 2 deals with the importance of geological field mapping. Section 3 is concerned with the planning while Section 4 outlines how to map, from the preparation stage, through the equipment required, the fieldwork, creating the map and writing the report. Aspects of the

risk assessment involved in fieldwork are presented in Section 5. Some concluding remarks are given in the last Section.

2. IMPORTANCE OF GEOLOGICAL FIELD MAPPING

The question can be asked as to Why Should Students "Do Geology" in the Field?

Some observations made at the symposium: "Geology Field Camp in the Geology Curriculum", Geological Society of America Annual Meeting, October 29, 1996, are most pertinent here.

(<http://www.geo.wvu.edu/~kammer/geol404.htm>)

A. By doing geology in the field, students learn by personal discovery a great deal of geologic information that they can use to solve geologic problems in the present and in the future. Students learn to integrate their knowledge from a variety of geologic sub-disciplines and then develop the skills and confidence to solve complex geologic problems. Students also learn how to collect and analyze field data and in so doing come to understand the limitations of such data. Students learn how to make and record observations in the field, formulate hypotheses, and then test their hypotheses. Finally, students learn how to make interpretations and predictions from data that are necessarily inadequate, incomplete, and imprecise, preparing them for solving problems as professional geologists.

B. All geological studies are ultimately based on geologic maps, field observations, or field sampling. All geologists need basic field skills, including the ability to read and locate on topographic maps and air photos, recognize geologic relationships at the "outcrop level", and collect and record rock descriptions, structural data, and other data systematically. However, the mere observation and recording of field data is an insufficient goal. These data must be analyzed, interpreted, and integrated into a geologic map and cross sections and also placed in a regional context. Creation of a geologic map requires that students develop and use a wide variety of field skills. During this process students make selective observations, formulate and test hypotheses, and wrestle with the uncertainties of field data, insufficient exposure, and the interpretive nature of geologic maps. In short, *they learn to think like a geologist.*

Regardless of whether graduates ever engage in field work, they will use geologic maps. Since ***geologic maps describe and interpret the earth***, the method of their creation is of singular importance to geologists. All geologists should experience the process of preparing a geologic map to develop an appreciation for the interpretive nature of geologic maps and the uncertainty inherent in field geology.

C. The purpose of field camp is to study rocks in the field and to learn how they have behaved -- rocks in pieces larger than hand specimens, which we study in the laboratory, and smaller than mountain ranges, which we study regionally. Students at field camp prepare geologic maps and measure stratigraphic sections because doing so is the only

way they can demonstrate that they understand the rocks. Thus what are typically regarded as the products of field camp -- maps-- are really a by-product. The scale at which students study rocks at field camp is more applicable to environmental problems than to the problems of more traditional branches of geology, such as petroleum exploration or tectonics.

Field geology offers students the opportunity to apply what has been learned in the classroom to real geological problems. Unless you already have fairly extensive field experience you should emerge from the course with a much deeper and more realistic appreciation of problems attending the collection, analysis, interpretation, and synthesis of geological information.

In the field, rocks look different than they do in textbooks or on lab benches. A valuable aspect of the field course is practice in approaching an outcrop and knowing what to do next. Even an incorrect solution to a field problem or a faulty interpretation of a geological event is of value because it prepares the way for a better solution or interpretation next time. As you get better at your job through practice, you gain confidence in your abilities. For this reason, a field course must stress individual effort and personal initiative. Students usually work in teams, primarily for safety, and we all realize that a good deal of learning can be derived from discussing ideas with classmates. But it is a student's own interpretation of the geology, developed from his/her own investigation, that will be of most value.

3. PLANNING A GEOLOGICAL FIELD MAPPING EXERCISE

As part of the planning process for a successful geological field mapping campaign, the following questions should be addressed:

- Why are you doing it?
- Are you going as a general exploration or do you have definite reason?
 - Your motives will affect the preparation and the items you will need to take.
- Where are you going?
- Do you need permission of the landowner, local community and village head in advance?
- What are the potential hazards that you are likely to encounter?

3.1 Protective Clothing

For all fieldwork you will need to have sensible clothing for the weather conditions. You must have the correct footwear for the site you plan to visit; non-slip

footwear for slippery rocks; comfortable walking boots for long distances. Some working quarries insist that you wear safety footwear with steel toecaps. High visibility clothing is a statutory requirement for some working quarries and is also worth considering in remote areas. A hard hat is required in all working quarries and on most organised trips. Impact resistant glasses or goggles should be worn if you plan to do any hammering; on an organised trip the leader may insist that you have them and wear them. Dark glasses are definitely helpful if you plan to undertake field work on a sunny day.

If you have the room in your bag, take some first aid equipment and perhaps some warm clothing in case you get stuck somewhere and have to spend the night or wait for help to arrive. A couple of dustbin liners could help keep you dry and warm in emergencies. A whistle could be used to attract the attention of others if you need help.

3.2 Safety

If you are working alone, always tell someone where you are going and when you plan to return. For coastal work always check the tide table and as a general rule always set off on a falling tide. Work out how long you can safely work before the tide will come in and cut off your exit route. Try to find out if there are other exit points from the beach by reading guide books or asking the advice of people who know the area. The tide may be affected by the weather conditions on the day, so always keep an eye on it.

In remote areas always check the weather forecast on the local television station or newspapers before setting off.

In working quarries report to the site office on your arrival and ask if there are parts of the quarry you should avoid, because of blasting, unstable faces, flooding etc. Always obey any safety instructions you are given and leave the site when asked. Maintaining a good relationship with quarry owners and foremen will mean that you should be welcome again and builds a responsible reputation for the geological community as a whole!

3.3 Equipment.

Your most important piece of geological equipment is your field note book! Do not rely on your memory! Don't forget something to write with; a pencil is best so you can write when it is wet. It is useful to have a large clear plastic bag so you can put your notebook in it and write when it is raining.

A geological hammer is used to chip bits off rock to be able to observe an unweathered surface. Make sure you know how to use it properly and efficiently. Use a cold chisel to extract fossils from rocks. Never use a hammer as a chisel because the hardened steel can splinter. Always wear safety glasses or goggles when hammering and make sure that nobody is standing near you when you use a hammer. Never hammer under an overhang. **Please** think carefully before you hammer or collect specimens; do you really need to? Please be considerate to other geologists who wish to visit the site. If

you must hammer or collect, try to use pieces from a scree or fallen blocks in preference to hammering the exposed rock face.

If you are collecting from clays or other soft rocks, a trowel will be useful.

If you plan to collect samples, you will need some sample bags. Self-seal plastic bags are suitable for most rocks, though tough cloth bags may be better for hard sharp edged specimens. Write the details on the bags and also on a piece of paper, which should be placed in the bag with the sample. Wrap delicate specimens in newspaper.

Remember to record the details of the rocks and samples you collect in your field notebook.

Other items of equipment required include:

- a tape measure to record the thickness of beds,
- a compass to find the directions of dips,
- a clinometer to measure dip angles,
- a hand lens to get a closer look at small-scale structures and fossils,
- a camera to take photos of what you find

3.4 Before you go

Write to or visit the landowner to get permission to enter the property or quarry. You may have to sign an indemnity form before you visit.

Check the map so you know where you are going and how to get there. Don't forget to make your packed lunch and take a drink (especially in hot weather)!

3.5 When you return.

If you did tell someone where you were going, for safety reasons REMEMBER to tell him or her you have returned safely!!!

Unpack your samples and check that they are properly labelled.

Read through your notebook and add any useful information that is missing. Do a neat copy of any graphic logs or other measurements you made, whilst the information is still fairly fresh in your mind.

Write a letter to the site owner or local community thanking them for their help, include a copy of any results of your work or offer to send a copy of any publication that may result from the visit. It is very useful to maintain a good relationship with site owners and often they are interested to learn more about their property.

3.6 Insurance.

Think seriously about some personal accident insurance.

Also check on your public liability insurance what happens as a result of your negligence? If you are leading a group of other people, get some insurance or make it very clear that you accept no responsibility. If you are leading a trip for an organisation you should insist that they arrange insurance cover¹.

4. HOW TO MAP

4.1 Preparation

Make sure that you know how to measure true dip using a clinometer and that you know how to use map coordinates.

Obtain your large scale base map - 1 to 10 000 scale is excellent. You will need a good clean copy as a master document to work from and another copy cut into manageable sheets for use in the field. Students need to appreciate the limitations of map scales in order to recognise that every detail cannot be put down on maps because there is limited space and that small features such as veins and minor dykes may therefore not be mappable.

Do a literature search - read about the local geology, field guides, articles in journals, map memoirs, Bulletin of the Geological Survey of Nigeria, etc. to get an idea of the geology of the area you intend to map. Visit the local library, contact the local geological or museum of natural history, search the world wide web. If there is a Department of Geology in a nearby university, it is worthwhile visiting their library for past student projects on your project area. However, there is a caveat here: Do not believe everything you read!

Try to find borehole information - look in map memoirs and journals. Perhaps you may wish to contact the Nigerian Geological Survey Agency, local government authority or Water Corporation or Board. Decide if you can trust the integrity of the data and interpretation.

Have a look at published geological maps of the area BUT do not be tempted to copy them. Copying them defeats the point of you own mapping and you will not get so much out of it. You will also be copying any mistakes they made - your task is to record and interpret the present day evidence which may not have been available in the past.

¹ At the University of Ibadan, there is a subsisting rule that stipulates that before any group of students can be permitted to embark on a field trip, they must be insured. This is a fall out of an unfortunate incident about year 2002 when some students from the Faculty of Education went on excursion and were involved in an auto accident and many of the students lost their lives. Due to absence of any such policy in the University at the time, those students were not insured and some of the parents and guardians of the deceased students took the University to court.

Get to know the geology and landscape of the area generally before you start the mapping in any detail. This will give you a "feel" of the geology, help you plan the work and enable you to do risk assessments.

Visit some key exposures to view the rock types in their unweathered form. This may mean going outside your mapping area to find these exposures. Whilst you are there pay attention to the weathering and soils that form on top of the rock.

You can now start to establish your own lithostratigraphy and biostratigraphy.

Calibrate your compass - your compass points to magnetic North and your maps coordinates are based on true North. If you want to record directions accurately then you should calculate the difference between your compass and the North on your map and adjust all readings you take in the field accordingly. To do this - when you are in the field find where you are exactly on your map, look for a landmark in the distance, take a bearing with your compass and then compare that with the angle from North on your map using a protractor.

4.2 Equipment required

There is not much point in doing fieldwork if you do not have the right equipment. But you will not want to carry too much around with you. So plan each day's work carefully in advance.

Make sure that you have the right clothing for the weather conditions and sensible footwear. Remember to have some food and drink in your rucksack, and perhaps a first aid kit and mobile 'phone.

For general mapping you will need - your base map, your geological note book, pen or pencil, a large clear plastic bag (so you can write in your notebook in the rain), a compass, a clinometer, a grain size scale, a geological hammer, a camera, some sample bags.

If you know you are going to go into quarries or are visiting coastal exposures take your hard hat, tape measure, chisel, trowel, perhaps some old newspapers to wrap larger fossils and rock samples.

If you are in areas with little exposure then take an auger.

4.3 Fieldwork

Always remember that you will be working mostly on private land. Where possible get permission and be respectful to landowners - explain what you are doing and you will often get snippets of useful information in return. Do not trample crops and do not disturb livestock. Never neglect your own safety or the safety of others.

Exposures - get the maximum information from exposures - rock types, thicknesses, dip, dip direction, fossils, etc. Collect small samples for comparison with other exposures, and perhaps future lab-work such as making thin sections, sieving for microfossils or chemical analysis. Getting dips and directions can be very helpful for your mapping - they can help you understand geological structures (such as folding, faulting and unconformities) and help you predict where outcrops should be (remember that horizontal beds run parallel to contours).

Field walking - look for fragments of rocks and fossils, but remember that these may have moved down slope from the sub-crop. Look for changes in soil. Keep to established footpaths or the edges of fields whenever possible - you will not damage crops that way and often there is some bare soil there most of the year. Farmers may move large boulders to the edge of the field so they do not cause damage to farm implements.

Stream sections - look in the bed and banks of streams and rivers for exposures or bits of rock. Remember rock fragments may have moved downstream from the outcrop.

Temporary exposures - look for road works, newly dug graves, gate post repairs, ditch clearance, rabbit or fox hole - any hole in the ground that may reach bedrock or the subsoil or provide a spoil heap.

Augering - using an auger to take samples of the subsoil and rock fragments. Do not screw the auger deep into the ground and then try to lift it out - you may break the auger or do yourself a mischief! Screw the auger in a short distance then lift it out, look at the sample and then put it back into the same hole, repeating the process until you hit something solid, get a satisfactory sample or just can't get any deeper.

Landscape - pay attention to the landscape: you will get clues about the geology. Changes in slope are probably due to a change in geology: a concave slope might indicate a soft rock under a harder one. Look for dip and scarp slopes. Look for spring lines indicating a permeable rock overlying an impermeable one. Dry valleys and underground drainage are indicators of limestone. Look at the depth of the soil - soils on limestone are usually quite shallow. Differences in plant life or land use are probably related to the geology.

Human activity - look at the building stone and walling in the area - local rocks will be used if suitable. Perhaps garden rockeries include local rocks. But be a bit skeptical about the evidence if humans have been involved - rocks used for walls, tracks, etc. may have been imported into the area or moved around it. It may be worth looking at old maps and historical books for evidence of old quarries and other land use. And always remember to visit the local pub and chat to people - you can often get bits of help by asking the locals "do you know about any quarries around here?" and things like that.

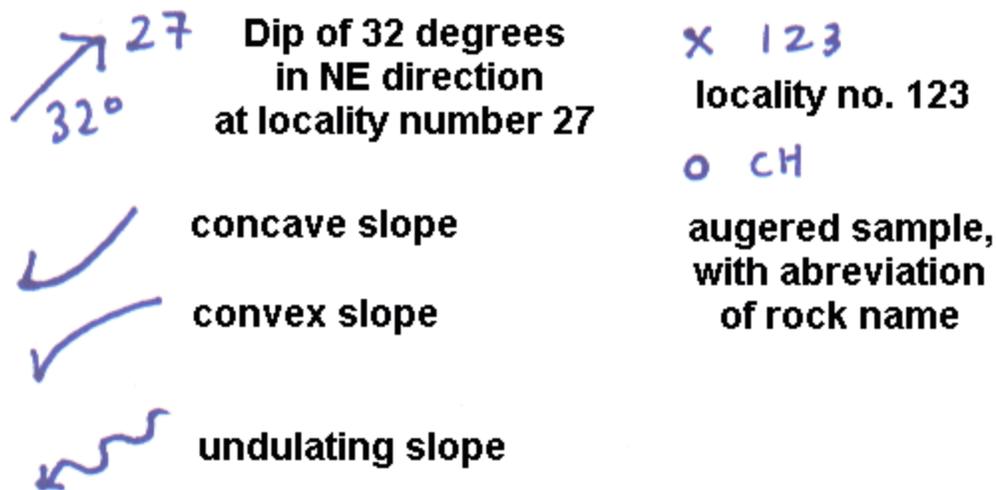
4.4 Creating the map -

In the field - mark localities on to the base map field slips that you have with you. It is suggested that you mark the spot with a cross and put the locality number used in your note book beside it. Then write the details in your note book, including the grid reference and locality name from the map. It is probably best to use a sharp hard pencil or a blue indelible pen.

When you have an exposure then show the dip with an arrow pointing in the direction of the dip and the dip in degrees written beside it. The head of the arrow should be on the place that you measure the dip and the locality number should be beside it.

You could show an augered transect with little circles and an abbreviation for the rock type found beside it, rather than giving each point a locality number.

You can use symbols or words to record landscape features that you think are significant.



On the good copy - Copy most of the information from your field slips onto a good copy of the map after each day's fieldwork. As the base map is probably printed in black on white, use a very fine blue pen. You can then start to mark in the boundaries between the rock types. Use a continuous line where you are sure of the boundary location, and dashed lines when you are less certain or guestimating. The same goes for other features like faults; faults are usually shown as a thicker line than boundaries.

The final geological map - This is a map that presents the results of you field mapping and it is best to a tracing based on you good copy of the map, showing the geology, exposure details, some landmarks, major roads and topography. It should not be cluttered with too much detail but anyone using such a map should be able to find their way around it. You do not need to include all locations and location numbers, you should identify them by their grid reference in your report.

 **Alluvium**

 **fault with indication of downthrow**

 **dip of 32 degrees north east**

 **horizontal bedding (dip = 0 degrees)**

 **disturbed ground or landslip**

 **quarry**

 **borehole**

 **definite boundary between rock types**

 **probable boundary between rock types**

 **possible boundary between rock types**

Colour the final map - either follow the standard conventions, or invent your own colouring system. Use faint colours for most rocks so that the colouring does not hide any of the details of the map. You can use brighter colours for thinner strata or outcrops to make them more obvious.

Remember to include a key for the symbols and colours used! Don't forget a scale too!!

4.5 Writing a report

The report gives further explanation and interpretation of the map as well as adding details about the lithostratigraphy and biostratigraphy.

There is a standard format for a map report (similar to a Nigerian Geological Survey Agency map memoir) which presents the information in a logical order. There is no reason why you cannot do your report differently, but following accepted practice is often easier!

[As with anything you write remember to keep to the copyright laws and avoid plagiarism. The use of quotations and diagrams from previously published work must be acknowledged]

The report would normally consist of:-

Title page and author. The title should be concise and informative - probably "The geology of...."

List of Illustrations

ABSTRACT - a short précis of the report that should make sense without reading the whole report, designed to give the reader the key points about the geology of the area.

The main part of the report split into sections or chapters (such as) -

INTRODUCTION - including the aims of the mapping, details previous research in the area (from your literature search), techniques used in the present investigation, geography and geomorphology.

THE ROCKS - a descriptive listing of the rock types in the area arranged in stratigraphic order with the oldest first. Include diagrams, pictures and logs wherever possible.

THE BIOSTRATIGRAPHY.

THE SUPERFICIAL DEPOSITS - Quaternary.

GEOLOGICAL HISTORY OF THE AREA.

GEOLOGY AND LANDSCAPE

ECONOMIC GEOLOGY AND HYDROGEOLOGY - uses of the rocks and water supply.

CONCLUSIONS.

REFERENCES OR BIBLIOGRAPHY - remember to follow accepted standards for referencing.

ACKNOWLEDGMENTS - thank the people who have helped you.

And don't forget to include a copy of the final map with your report, either attached to the back cover or in the same folder.

A more detailed discussion on improving skills in technical writing in the geosciences has been given by Ogezi (1996)

5. RISK ASSESSMENT.

This is a generic safety statement and risk assessment for geological fieldwork. Students should be given verbal safety instructions and a copy of this document before

the trip, and be reminded at the start of the field trip. Additional information will be given by the supervisor at the start of the fieldwork about local hazards, because they depend on the weather at the time of and leading up to the fieldwork or information on site provided by the landowner.

General safety:-

Clothing: Clothing must be suitable for the weather conditions. Water proofs for wet weather; sun block for hot sunny weather and so on. The right sensible footwear is essential: - wellingtons recommended for work in areas of clay and mud; non-slip trainers for slippery rocks; stout walking boots for long distances.

Protective clothing: Hard hats must be worn in quarries and near cliffs. Safety Spectacles must be worn when hammering. Working quarries may insist that steel toe capped footwear, hard hats, safety specs and high-visibility waistcoats must be worn at all times.

Bacterial infections:- There is a risk of infection from bacteria - e.g. tetanus and Weil's disease. Students are advised to check that they are immunised against tetanus; cover any cuts to the skin; wash and disinfect any cuts and scratches; wash their hands before eating and drinking.

Behaviour: Students should follow the safety instructions of the supervisor (and quarry staff) and behave in a responsible manner. They should not use a hammer if someone else is standing nearby. They should not hammer under an overhang. Students should collect rocks in an ethical way, with considerations of the status of the site and its use by others. Hammering and collecting are banned at some sites. They should not wander away from the main group or leave the field trip without informing the supervisor. Students with a disability should discuss any possible risks with the supervisor before the field trip begins. Students with first aid experience are asked to volunteer their help to the supervisor.

Fitness: Fieldwork may involve walking on gravel or slippery shores or steep gradients. The classes may be taken to areas that have generally good access used by the public and not involving climbing or very steep slopes. Students do not have to be super fit sporty types, but those with heart/asthmatic problems or walking difficulties may wish to reduce the amount of fieldwork they do.

Emergency action: at least one person in the group should have a mobile 'phone to be able to reach the supervisor or any other responsible persons in case of any emergency. There should be a first aid kit to deal with minor cuts.

The supervisor reserves the right to ban any student from the field trip if he/she is not appropriately dressed or behave in an irresponsible manner. The supervisor assumes that students are all adults and that they are aware of their own capabilities for

fieldwork. Students who think they may have a problem that might affect their safety or that of the group should inform the Supervisor (privately).

Insurance: students are advised to take out their own accident insurance.

To get the hazards and risks into perspective it might be useful to compare them with some other everyday activities. The hazards involved in geological fieldwork are slightly greater than those involved in rambling (i.e. walking in the country side for pleasure). The hazards involved in collecting and handling samples are similar to those involved in gardening. And the hazards involved in hammering are similar to those encountered in some DIY (Do It Yourself).

Each student may be required to submit a standard **physical examination**, signed by a physician, with approval for "strenuous activity." Field work can at times be very strenuous, hence students are expected to be physically and mentally fit.

The hazard and risks associated with some of the field work activities and remedial action that could be taken in such cases are outlined below.

ACTIVITY	HAZARD	RISK	ACTION
Handling geological specimens and collecting geological samples	Potential chemical and biological hazards.	Moderate	<ul style="list-style-type: none"> • Ensure that any cuts to your skin are cleaned and covered up. • Consider wearing gloves. • Always wash or clean your hands before eating and drinking in the field.
Hammering or using a hammer and chisel	pieces of rock may fly off and cause injury to you or others nearby	moderate to high depending on your experience	<ul style="list-style-type: none"> • Always wear safety goggles or glasses. • Never use a hammer if other people are near you. • Never use a second geological hammer as a chisel. • Never hammer under an overhang or on a loose rock face. • Consider wearing thick gloves to protect your hands.
Handling specimens	Sharp edges - some specimens, especially "hard rocks" that have	Moderate to high	<ul style="list-style-type: none"> • Carry out a visual inspection before handing specimens, do not hold the sharp edges and take

	been recently hammered, may have sharp edges that could cause cuts.		<p>care when handing specimens to other students.</p> <ul style="list-style-type: none"> • Wear stout gloves when hammering "hard rocks". • Do not discard rock fragments with sharp edges in fields where there will be a hazard to livestock and wildlife
General fieldwork in open countryside	getting stuck in marshy areas, aggression from the livestock, getting knocked down by fast moving vehicles on roads	moderate	<ul style="list-style-type: none"> • Avoid marshy areas if possible (but if not wear wellies and test the ground in front of you with a stick); • keep away from livestock (particularly cattle, bulls, horses and sows with piglets); take the normal route you would on any road (if possible arrange for someone in the group to watch out for traffic if you are in a particularly hazardous position). Remember to follow the 'Country Code'.
Fieldwork on coastal sections	incoming tide trapping the class on the beach	moderate, but serious	<ul style="list-style-type: none"> • Fieldwork should always start on a falling tide and the class should be aware of local conditions and ensure that there is adequate time to return safely before the next high tide.
Fieldwork on coastal sections	slipping on wet rocks, chance of cuts and bruising or worse if you slip over	moderate	<ul style="list-style-type: none"> • Students should take extra care on wet rocks (due to seawater or rain) and be wary of rocks covered with wet seaweed and algae. • Wearing non-slip footwear such as trainers

			is recommended.
Fieldwork near cliffs or quarry faces	falling rocks	moderate	<ul style="list-style-type: none"> • Always wear a hard hat. Always look at the rock face and avoid areas that are cracked or overhanging. • Keep the time spend near the rock face to a minimum (once you have carried out the fieldwork activity get away from the face - for example don't stop there to eat your lunch). • Do not approach quarry faces that have been recently blasted with explosives.
Fieldwork on muddy exposures	you can get stuck in soft mud and clay	high	<ul style="list-style-type: none"> • Care should be taken when approaching recent mudslides or muddy parts of quarries. • Wellington boots are the recommended footwear (you can get your feet out of the wellies and walk home without them). • Test the area with a stick or pebble before walking on it. • Keep away from recent mudslides down cliffs, particularly in or after wet weather.
Fieldwork in working quarries	(in addition to hazards listed above) there may be quarry vehicles, recently blasted rocks, sludge lagoons.	high	<ul style="list-style-type: none"> • Hard hats must be worn at all times in all working quarries. • The instructions given by quarry staff or owners must be followed at all times. The owner may insist that people wear safety glasses, high

			<p>visibility waistcoats or safety footwear - these instructions must be followed.</p> <ul style="list-style-type: none"> • The party should avoid areas in which diggers and lorries are working, areas of soft ground or lagoons, areas of loose or recently blasted rock, and not be present during times of rock blasting. • Students should keep away from and not interfere with any machinery and vehicles in the quarry.
Fieldwork in landfill sites	sharp and broken contaminated objects	the risk of bacterial infections and other biohazards is greater than other sites.	<ul style="list-style-type: none"> • The site owner may insist on safety footwear with a steel sole. • Consider wearing heavy duty gloves at all times. Ensure that any cuts to your skin are covered up. • Wash your hands as soon as possible after leaving the site. • Any specimens collected should be washed (if the washing will not damage the specimen) and treated with extra care.
Augering to obtain samples of sub-soil	heavy lifting when removing auger from hole	back strain	<ul style="list-style-type: none"> • do the augering in stages - don't put the auger in so deep that it is difficult to lift out. • Always lift using your leg muscles rather than by bending your back. • Ask someone else to help you.

6. CONCLUSION

Geological field mapping is central to the training of a professional geologist. The graduate geologist is expected to have acquired sufficient training to be able to interpret topographic and geological maps accurately, accurately identify minerals, rocks and fossils in the field and make systematic descriptions of them, interpret and communicate field and laboratory data on samples and explain how rock-forming processes have shaped the landscape of an area, and use geological data and maps to infer possible economic benefits and the environmental resources and problems of the study area. The planning that has to go into any field mapping must be very detailed in order to ensure a successful exercise. Some of the preparations involved in this have been outlined in this paper. The need for a careful recording of outcrop information from igneous, metamorphic and sedimentary rocks have been stressed, as well as maintaining field notebooks, map preparation and report writing. An overview of some of the hazards and risks involved in geological field mapping and remedial actions that should be taken have also been given. It is hoped that a careful consideration of these points will go a long way in assisting in a worthwhile field mapping by students.

REFERENCES

- Geological Fieldwork Code*. London: The Geologists' Association
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Appendix 1. The Geological Code (after The Geologists Association)

- Obey the Country Code
- Always asked permission when entering private property
- Don't interfere with machinery
- Don't litter the ground with rock fragments, or drop pieces from other sites
- Don't disturb wildlife and plants
- Check tides and local hazards
- In remote areas tell someone your intended route and the time you are due back *and* remember to tell them when you have returned safely!
- Never go underground in caves or mines alone
- Don't take risks on insecure rock faces or endanger others
- Be considerate; leave no traces of your activities

Hammering and collecting:

- Always wear eye protection when hammering
- Observe and record - don't hammer indiscriminately
- Keep collecting to a minimum - collect from screens or waste it is and try to avoid collecting in situ material
- Never collect from walls or buildings
- Never hammer underneath an overhang
- Don't undermine fences, roads or buildings
- Don't disfigure rock faces and spoil them for others

In quarries:

- get permission before entering
- Wear protective clothing such as hard hats, goggles, safety boots and high visibility waistcoats (these may be required as a condition of entering the site)
- Report your arrival and departure
- Keep away from any machinery or vehicles
- Keep away from unstable faces
- Checked on blasting areas and times.
- Keep away from areas that have been blasted recently.
- Beware sludge lagoons