Field Geology

Unit V

Unit V : SYLLABUS

Field geological report: parts and preparation. Geological and topographic map symbols. Brief introduction of field indicators used in geological mapping: geomorphological, weathering, mineral composition and petrography.Geological materials: types of samples – mineral,ore,fossil,rock. Methods of sampling -care and packing of samples in the field. outline of preparation of thin sections of geological samples.

Field geology report.

Parts and Preparation

Geologic reports are prepared to provide specific information needed to plan and conduct an organized activity, usually engineered construction or mineral resource development.

Geologic reports are compiled by individual geological consultants or by consulting firms. The report is compiled at the request of a client who requires specific geologic information to be able to plan or design a development.

Field notes record the detailed observations of geologists working in the outdoors. Typical notebook entries include sketches of geomorphological landforms and outcrop features, preliminary maps and cross-sections (q.v.), detailed maps of critical or complex areas (e.g., contacts and faults), stratigraphic sections, tabulated quantitative data (e.g., structural measurements), pit and trench logs (see Vol. XIII: *Pipeline Corridor Evaluation*) lists and descriptions of samples and fossils, and a variety of written notes. The notebook contains the first record of the field geologist's observations and the interpretation of what he or she sees in the field and is a testament to the old Chinese proverb that “the faintest ink is better than the best memory.”

The field notebook represents the first link in a long chain of geological data gathering, mapping (see Geological Survey and Mapping), interpretation, and presentation. It represents not only the first record but also the most complete...

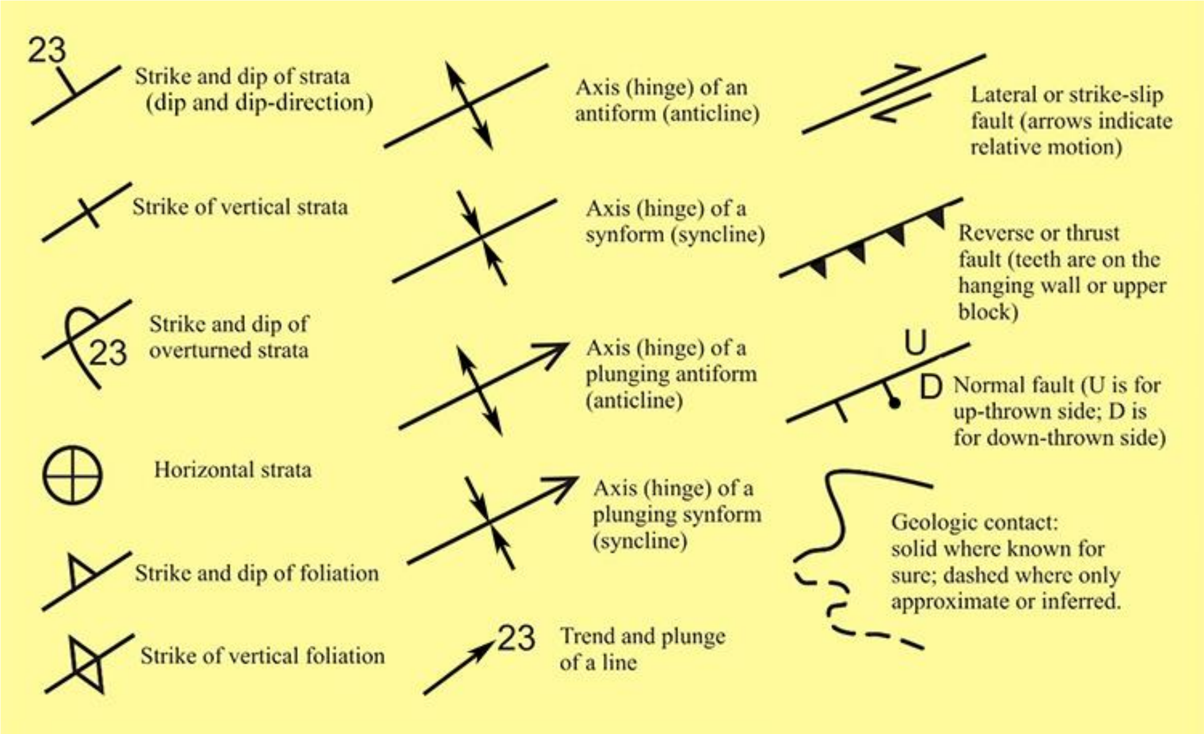
Geological and topographical map symbol

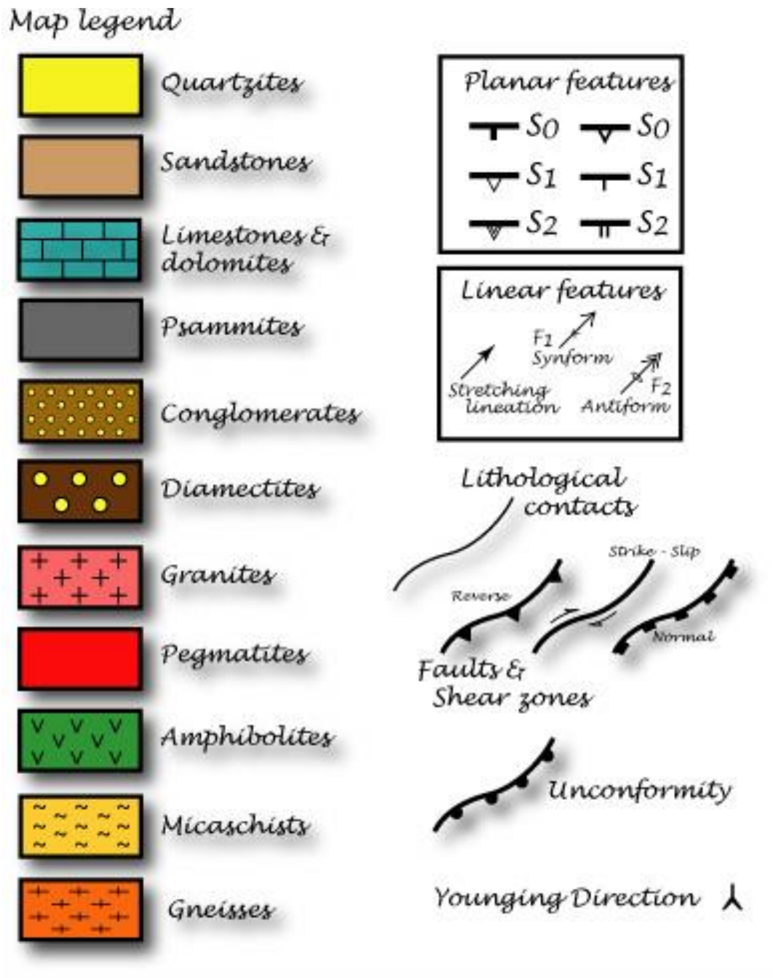
A symbol is an abstraction or pictorial representation of something else. Symbols on a map consist of discrete points, lines, or shaded areas; they have size, form, and (usually) color. Map symbols present information collectively, leading to appreciation of form, relative position, distribution, and structure. Locations of symbols on a map are controlled by positions on the ground, an element of cartography that cannot be changed (Keates, 1980). By digitization, symbols are conveniently stored and reproduced by computer.

Although the origin of symbols used in communication is lost in antiquity, they receive ever-increasing use in technical applications. Letters of the alphabet are essentially symbols of voice sounds, and numerals convey the concept of precise quantities. Because words alone cannot identify or describe areal details, abstract and pictorial symbols have become essential ingredients of maps. The symbols used by ancient cartographers were pictorial and highly fanciful;...

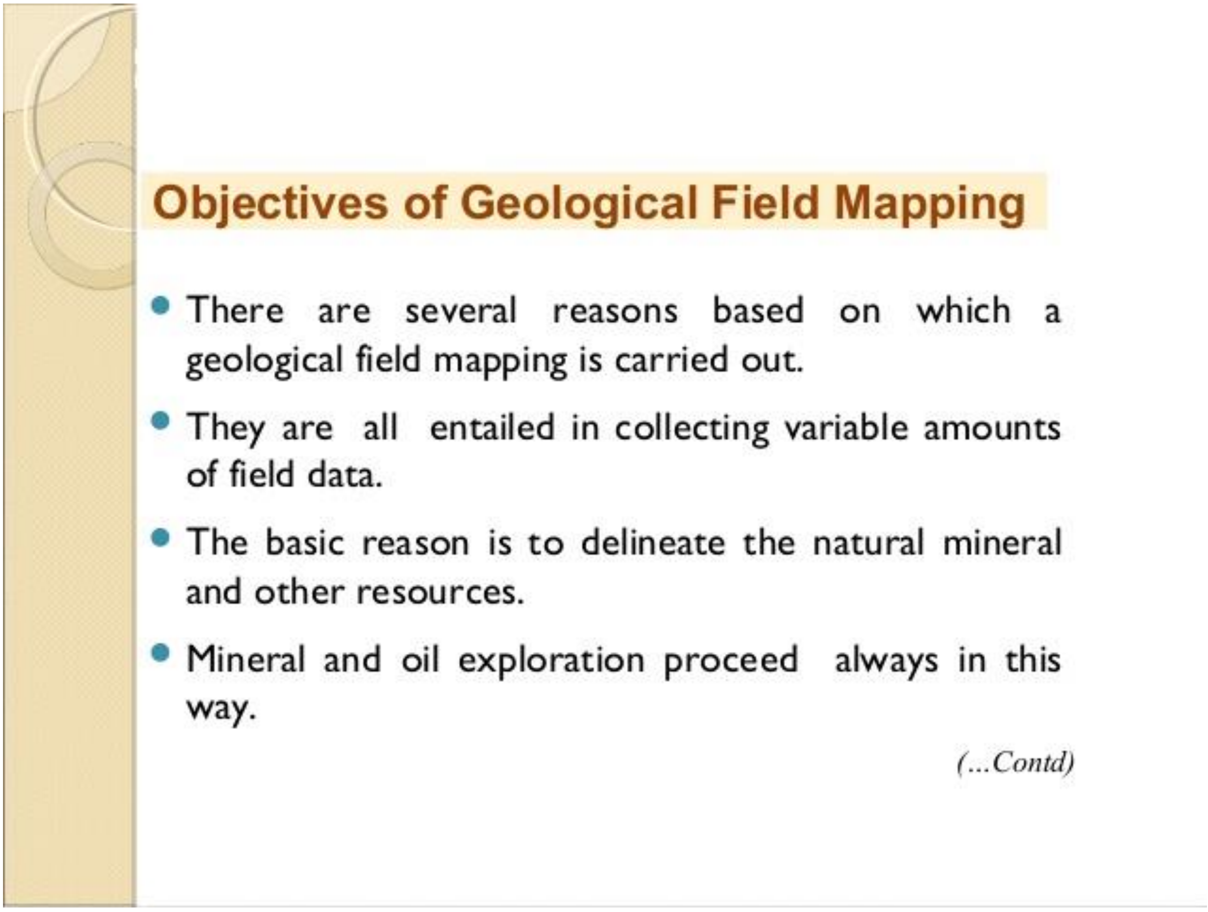
Topographic Map Legend and Symbols

- Brown lines – contours (note that intervals vary)
- Black lines – roads, railroads, trails, and boundaries.
- Red lines – survey lines (township, range, and section lines)
- Blue areas – streams and solid is for larger bodies of water.
- Green areas – vegetation, typically trees or dense foliage.


23
Strike and dip of strata (dip and dip-direction)
Strike of vertical strata
23
Strike and dip of overturned strata
Horizontal strata
Strike and dip of foliation
Strike of vertical foliation
Axis (hinge) of an antiform (anticline)
Axis (hinge) of a synform (syncline)
Axis (hinge) of a plunging antiform (anticline)
Axis (hinge) of a plunging synform (syncline)
23
Trend and plunge of a line
Lateral or strike-slip fault (arrows indicate relative motion)
Reverse or thrust fault (teeth are on the hanging wall or upper block)
U
D
Normal fault (U is for up-thrown side; D is for down-thrown side)
Geologic contact: solid where known for sure; dashed where only approximate or inferred.


Map legend
Quartzites
Sandstones
Limestones & dolomites
Psammites
Conglomerates
Diamectites
Granites
Pegmatites
Amphibolites
Micaschists
Gneisses
Planar features
S0
S0
S1
S1
S2
S2
Linear features
F1 Synform
Stretching lineation
F2 Antiform
Lithological contacts
Reverse
Strike - Slip
Normal
Faults & Shear zones
Unconformity
Younging Direction

Field indicators used in geological mapping



Objectives of Geological Field Mapping

- There are several reasons based on which a geological field mapping is carried out.
- They are all entailed in collecting variable amounts of field data.
- The basic reason is to delineate the natural mineral and other resources.
- Mineral and oil exploration proceed always in this way.

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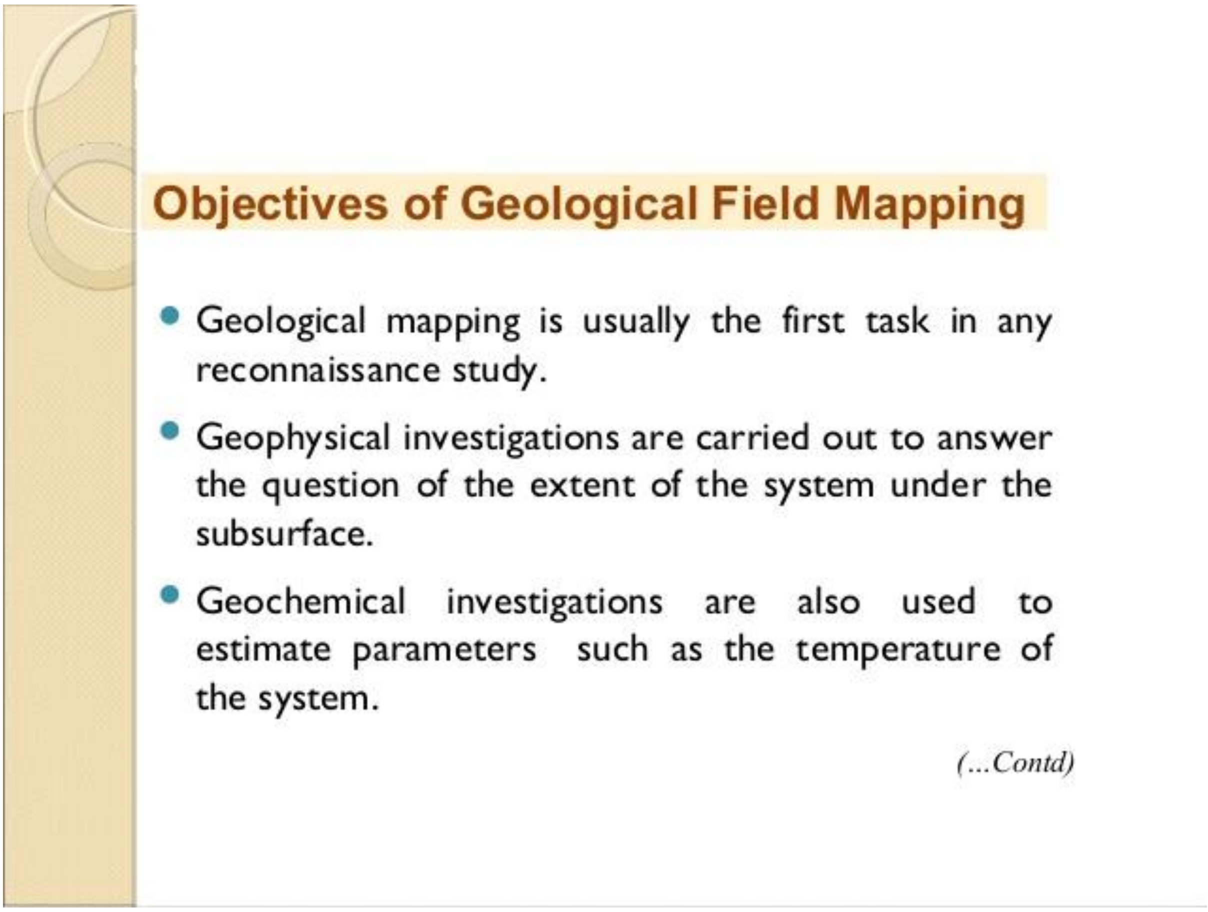

Objectives of Geological Field Mapping

- Geological mapping is usually the first task in any reconnaissance study.
- Geophysical investigations are carried out to answer the question of the extent of the system under the subsurface.
- Geochemical investigations are also used to estimate parameters such as the temperature of the system.

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Geomorphological

Several geomorphic features, erosional or depositional, develop near sea level. Some of them may be preserved after a change in sea level and can be used, therefore, as indicators of former sea-level positions. Erosional indicators can be preserved only in hard rock, and occur in a vertical range which depends on site exposure. They include notches, benches, trottoirs, platforms, abrasional marine terraces, strandflats, pools, potholes, sea caves, honeycomb features, and tafoni. For accurate sea-level reconstructions (Pirazzoli, 1996), it is essential therefore to refer the elevation of a former indicator to that of the active counterpart in the same place rather than to that of the present sea level. Depositional indicators include tidal flats, marine-built shore platforms and terraces, beaches, beachrocks, reef flats, and submerged speleothems. Erosional features are generally inadequate to date former sea levels, whereas marine deposits may include guide fossils

Geomorphic indicators of past sea levels represent a continuum of processes and landforms associated with sea level and sea-level change. In an attempt to honor this continuum, while at the same time discussing geomorphic features separately, this chapter discusses geomorphic indicators of past sea level in the following sequence. First, coral as a geomorphic indicator of past se level is discussed. The recognition of late Pleistocene uplifted coral platforms as indicators of past sea level was one of the pioneering efforts in sea-level research. Decades later, coral was again the focus of pioneering work in late Holocene sea-level research when coral microatolls were used to reconstruct sea-level history to a much higher resolution of centimeters of sea-level change over the scale of years. Erosional landforms that indicate former sea levels are then discussed, starting with late Pleistocene geomorphic features, marine terraces, and shoreline angles, before describing the more highly resolved sea-level records that can be gleaned from similar features in the late Holocene through the use of the seacliff–shore platform junction. Tidal notches form another set of erosional indicators that are discussed. Finally, the suite of geomorphic landform indicators that are deposits are discussed. Coastal deposits were initially laid down near sea level and such deposits, if subsequently vertically or horizontally separated from the shoreline, may indicate past sea levels.The discussion on deposits focuses on beach ridges.

Weathering

The CIA is calculated as where the elemental abundances are expressed as molar proportions, and CaO* represents the CaO contained only in the silicate fraction. The CIA is generally used to provide an indication of the relative abundances of "unweathered" material and chemical weathering products; {lie "unweathered materials of particular interest are the feldspars, which are common and contain relatively mobile Ca, Na, and K, whereas the chemical weathering products of particular interest are the Al-rich clays.

However, the CIA of a sample can also be affected by the grain size of the sample and by the provenance of the sediment, as discussed in more detail below. The CIA of a sediment increases as the extent of chemical weathering increases, from values of approximately 50 for "unweathered" feldspar-rich rocks to values near 100 for highly weathered, kaolinite- o1- gibbsite-rich sediments. CIA values for "average" shales. dominated by illite, range from 70 to 75 (Young & Nesbitt, 1998). The CIA value for a sediment also tends to increase as grain size decreases, because clay minerals are preferentially enriched in the finest grain sizes. As a result, the CIA was originally proposed for use with true shales or "lutites" (Nesbitt & Young, 1982). In a sequence where true shales are rare, such as the section cored at CRP-2/2A, care must be taken to consider the potential effect of grain size variations on stratigraphic trends in the CIA. The provenance effect is particularly important if sediment provenance changed significantly during deposition of a stratigraphic sequence, and if any of the potential sediment sources has an unusual geocheniical composition. Such aprovenance effect must be considered for CRP-2/2A because potential source rocks include two basic igneous units, the McMurdo Volcanic Group and the Ferrar Dolerite, whose bulk geochemistries produce CIA values lower than the CIAs of unweathered feldspar. The A120JTi0, ratio of a sediment can serve as a preliminary indicator of that sediment's source rock composition (Nesbitt, 1979; Young & Nesbitt, 1998) for two reasons: 1) the ratio varies markedly in primary igneous rocks, from approximately 10 for basalts and gabbros to approximately 47 for granites (LeMaitre, 1976), and 2) A1 and Ti are both considered to be relatively immobile under most weathering regimes. Trace element abundances can also serve as valuable indicators of sediment provenance because trace elements are also relatively immobile during weathering, and because trace element abundances can vary significantly between two igneous or metamorphic bodies with relatively similar major element compositions (e.g., two granites can have significantly different trace element compositions). In this study, concentrations of the trace element Nb are used to identify the relative importance of input from the McMurdo Volcanic Group, a potential source rock with elevated Nb contents.

Mineral composition

Some index minerals that indicate the presence of natural gas hydrates are carbonates, sulfates, and sulfides with specific compositions and morphologies. These mineral indicators are formed by the interaction of mineral fluids with seawater, pore water, and sediments during sedimentation, diagenesis, and catagenesis.
When fluids from the shallow seafloor enter the sea via venting or percolation, a series of physical, chemical, and biological processes occur. Gas-saturated fluids migrating upward from deeper sediments to the shallow seafloor will chill quickly to form gas hydrates. Depending on the fluid, some associated autogenic carbonate and autotrophic biocommunities may also form. These fluids are referred to as cold springs because of their low temperatures and are distinguishable from fluids with higher temperatures from the deeper crust, making them an effective indicator for gas hydrate.

Petrography

Through integration of geological, logging, and seismic data, technical approaches can be established by incorporating technical solutions of hierarchical identification and multiple prediction methods (Figure 5.1). Following this process, the lithological identification and prediction techniques for volcanic reservoirs are developed, which provide a basis for lithofacies identification, reservoir parameter interpretation, and gas layer and aquifer identification.

Geological material

Types of samples

Mineral

The primary methods used to extract minerals from the ground are:

1. Underground mining

2. Surface (open pit) mining
3. Placer mining

The location and shape of the deposit, strength of the rock, ore grade, mining costs, and current market price of the commodity are some of the determining factors for selecting which mining method to use.

Higher-grade metallic ores found in veins deep under the Earth's surface can be profitably mined using underground methods, which tend to be more expensive. Large tabular-shaped ore bodies or ore bodies lying more than 1,000 feet (300 m) below the surface are generally mined underground as well. The rock is drilled and blasted, then moved to the surface by truck, belt conveyor, or elevator. Once at the surface, the material is sent to a mill to separate the ore from the waste rock.

Lower grade metal ores found closer to the surface can be profitably mined using surface mining methods, which generally cost less than underground methods. Many industrial minerals are also mined this way, as these ores are usually low in value and were deposited at or near the Earth's surface. In a surface mine, hard rock must be drilled and blasted, although some minerals are soft enough to mine without blasting.

Placer mining is used to recover valuable minerals from sediments in present-day river channels, beach sands, or ancient stream deposits. More than half of the world's titanium comes from placer mining of beach dunes and sands. In placer operations, the mined material is washed and sluiced to concentrate the heavier minerals.

Ore

Ore is natural rock or sediment that contains one or more valuable minerals, typically containing metals, that can be mined, treated and sold at a profit. Ore is extracted from the earth through mining and treated or refined, often via smelting, to extract the valuable metals or minerals.[1] The *grade* of ore refers to the concentration of the desired material it contains. The value of the metals or minerals a rock contains must be weighed against the cost of extraction to determine whether it is of sufficiently high grade to be worth mining, and is therefore considered an ore.[1]

Minerals of interest are generally oxides, sulfides, silicates, or native metals such as copper or gold. Ores must be processed to extract the elements of interest from the waste rock. Ore bodies are formed by a variety of geological processes generally referred to as ore genesis.

The basic extraction of ore deposits follows these steps:

1. Prospecting or exploration to find and then define the extent and value of ore where it is located ("ore body").
2. Conduct resource estimation to mathematically estimate the size and grade of the deposit.
3. Conduct a pre-feasibility study to determine the theoretical economics of the ore deposit. This identifies, early on, whether further investment in estimation and engineering studies is warranted and identifies key risks and areas for further work.
4. Conduct a feasibility study to evaluate the financial viability, technical and financial risks and robustness of the project and make a decision as whether to develop or walk away from a proposed mine project. This includes mine planning to evaluate the economically recoverable portion of the deposit, the metallurgy and ore recoverability, marketability and payability of the ore concentrates, engineering, milling and infrastructure costs, finance and equity requirements and a cradle to grave analysis of the possible mine, from the initial excavation all the way through to reclamation.
5. Development to create access to an ore body and building of mine plant and equipment.
6. The operation of the mine in an active sense.
7. Reclamation to make land where a mine had been suitable for future use.

Fossils

Fossils are generally found in sedimentary rock with differentiated strata representing a succession of deposited material.[1] The occurrence of fossil bearing material depends on environmental factors before and after the time of preservation. After death, the first preserving factor is a rapid burial in water bodies or terrestrial sediment which would help in preserving the specimen.

These rocks types are usually termed clastic rock, and are further subdivided into fine, medium and coarse grained material. While fossils can be found in all grain types, more detailed specimens are found in the fine grained material.[2] A second type of burial is the non-clastic rock, form where the rock is made up of the precipitation of compacted fossil material, types of rock include limestone and coal. The third fossil bearing material is the evaporates, which precipitate out of concentrated dissolved salts to form nodular deposits, examples include rock salt and phosphate concentrations. The evaporates are usually associated with gastropod, algae, vertebrate, and trace fossils. Fossils are not to be found in areas of igneous rock (except in some beds between lava flows). In rocks which have undergone metamorphism, fossils are generally so distorted that they are difficult to recognize or have been destroyed completely.[3]

Preservation[edit]

After burial various factors are at work to endanger the current fossil's preserved state. Chemical alteration would change the mineral composition of the fossil, but generally not its appearance, lithification would distort its appearance, the fossil itself may be fully or partially dissolved leaving only a fossil mold.

Exposure

College students collecting fossils as part of their invertebrate paleontology course. This is a roadside outcrop of Ordovician limestones and shales in southeastern Indiana.

Areas where sedimentary rocks are being eroded include exposed mountainous areas, river banks and beds, wave washed sea cliffs, and engineering features like quarries and road cuts. Coal mining operations often yield excellent fossil plants, but the best ones are to be found not in the coal itself but in the associated sedimentary rock deposits called coal measures.

Wave-washed sea cliffs and foreshore exposures are often good places to search for fossils, but always be aware of the state of the tides in the area. Never take chances by climbing high cliffs of crumbling rock or clay (many have died attempting it). Dried up natural lake beds [5] and caves in the form of pitfall traps [6] frequently also have high concentrations of fossils (e.g., Cuddie Springs and Naracoorte Caves in Australia).

Generally in appearance, a fossil will be either a different colour to the surrounding rock, because of the different mineral content, will have a defining shape and texture or a combination of both. A fossil can also be extracted from its geological environment, having similar characteristics in colour naturally embed from the sedimentary formation (surrounding rock) it was found within.[4]

Collecting techniques

The techniques used to collect fossils vary depending on the sediment or rock in which the fossils are to be found. For collecting in rock a geological hammer, a variety of cold chisels and a mallet are used to split and break rocks to reveal fossils. Since the rock is deposited in layers, these layers may be split apart to reveal fossils. For soft sediments and unconsolidated deposits, such as sands, silts, and clays, a spade, flat-bladed trowel, and stiff brushes are used. Sieves in a variety of mesh sizes are used to separate fossils from sands and gravels. Sieving is a rougher technique for collecting fossils and can destroy fragile ones. Sometimes, water is run through a sieve to help remove silt and sand. This technique is called **wet sieving**

Fossils tend to be very fragile and are generally not extracted entirely from the surrounding rock (the matrix) in the field. Cloth, cotton, small boxes and aluminum foil are frequently used to protect fossils being transported. Occasionally, large fragile specimens may need to be protected and supported using a jacket of plaster before their removal from the rock. If a fossil is to be left in situ, a cast may be produced, using plaster of paris or latex. While not preserving every detail, such a cast is inexpensive, easier to transport, causes less damage to the environment, and leaves the fossil in place for others.

Fossilized tracks are frequently documented with casts. Subtle fossils which are preserved solely as impressions in sandy layers, such as the Ediacaran fossils, are also usually documented by means of a cast, which shows detail more clearly than the rock itself.

Preparation and cleaning

Fossil preparation

Sometimes, for smaller fossils, a stiff brush may simply be used to dust off and clean the fossil. For larger fossils, a chisel can be used to remove large bits of dirt, however, you run the risk of damaging the fossil. Running water can cause some types of fossils to either dislodge from the rock, or even crumble and break apart, for they are very fragile. Dental tools are sometimes used to remove small amounts of rock from the fossil.

Rocks

Systematic rock sampling can be used to characterize a geothermal reservoir. The physical and chemical properties of rock samples provide important information for determining whether a power generation or heat utilization facility can be developed. Some general rock properties can be measured by visual inspection, but detailed properties require laboratory techniques.

There are **rock samples** that can be **collected** on the surface, in outcrop, which may reveal important information about the geothermal resource at depth. These hand **samples** can be **collected** using a **rock** hammer or sledge.

Subsurface Sampling A rock sample for geothermal exploration is typically collected from a drilled well, and initial analysis of the rock type, mineralization, composition, textures, etc. are collected in the field at the drill site or from core and cutting samples that have since been stored in a repository. However, the more in depth rock properties often require laboratory tools.

Surface Sampling

There are rock samples that can be collected on the surface, in outcrop, which may reveal important information about the geothermal resource at depth. These hand samples can be collected using a rock hammer or sledge.

Methods of sampling

There are two types of sampling methods:

- **Probability sampling** involves random selection, allowing you to make strong statistical inferences about the whole group.
- **Non-probability sampling** involves non-random selection based on convenience or other criteria, allowing you to easily collect data.

Care and packing of samples in the field

The geological *sample* is a representative unit of soil, rock, ore, fluid, or gas that is selected from a larger mass or volume to serve as an example of that larger body or to reflect some specific feature or variation within it. The simple rationale for *Sampling* (Barnes, 1981) is that, one can take a specimen home, but not an outcrop. Sampling is undertaken to provide a type specimen for classification purposes and/or special-purpose (e.g., petrofabric) analysis, assay, or testing (including engineering-geological and geochemical testing).

Rock **specimens** should be placed in suitable **sample** bags equipped with drawstrings and sewn-on water proof labels. Whenever practical, **specimens** should be neatly numbered with a waterproof felt tip marker. Delicate **samples** should be wrapped (in newspaper) before bagging (some **geologists** wrap all **samples**).

Specific instructions on the exact type, number, and distribution of samples to be collected cannot be given, but some general guidelines should be followed:

1. The judgment of the geologist must be applied toward obtaining samples which will be most representative of the coal bed.

2. Only samples of fresh or unweathered coal should be submitted for analysis, preferably collected from a newly exposed mine face or from a drill core. The samples should be shipped to the laboratory

within a few days after collection to minimize the effect of oxidation and exposure to air on the moisture content and on the forms of sulfur.

3. The objective should be to obtain a complete channel sample or core of the minable bed; if the coal bed is more than 5 feet (1.5 m) thick, a good rule-of-thumb is to collect one sample of each 5-foot (1.5-m) interval of coal (for example, four samples of a bed 20 ft, or 6 m, thick). Special-type samples (prominent fusain band or pyrite lens, for example) will also be analyzed at the discretion of the geologist.

4. Generally, 4 to 5 pounds (1.8 to 2.3 kg) of coal should be included in each sample; for rock samples, 2 pounds (0.9 kg) is sufficient

. 5. A satisfactory channel sample, for example, can be obtained from a coal bed in a mine by first exposing a new, fresh face of the coal, then chipping an approximately 3-inch by 3-inch (7.5 cm by 7.5 cm) channel downward from the top of the bed with a chisel or pick-point hammer, producing coal fragments 2 inches (5 cm) or less across. Positioning a horizontal plastic sheet below the level of channel cutting is sometimes helpful, particularly if coal accumulates in excess of the desired sample size, and cone-and-quartering separation of the coal is needed to obtain the representative sample.

6. Plastic bags (10 x 15 in., or 25.4 x 38 cm, or larger; thickness 0.006 in. or 0.15 mm) should be used for the sample, and care should be taken to avoid contact of the coal with metal during and after collecting sample (the use of a geologic hammer, of course, cannot be avoided); sample number, date of collection, and key description should be written with a felt-tipped marker pen (permanent ink) on each bag, and on a label attached to the tie on the bag.

Preparation of thin section

Rock samples-typically cores or individual grab samples, require processing before they can be used for mineral analysis by either PLM (Polarizing Light Microscope, Microprobe and Scanning Electron Microscope/X-ray Microanalysis. The sample has to be thin enough for light to pass through in a light microscope and have a polished surface for electron microscope studies.

STEP 1: CUTTING A SLAB A suitable size slab for mounting on a slide is cut from a piece of rock or drill core with a diamond saw

STEP 2: Initial Lapping of the Slab The slab is labelled on one side and the other side is lapped flat and smooth first on a cast iron lap with 400grit carborundum, then finished on a glass plate with 600 grit carborondum

STEP 3: Glass Slide is Added After drying on a hot plate, a glass slide is glued to the lapped face of the slab with epoxy.

STEP 4: Slab is sectioned Using a thin section saw, the slab is cut-off close to the slide. The thickness is further reduced on a thin section grinder.

Powders are mixed with expoxy, then spread on a slide and allowed to cure. The surface is ground flat on the thin section grinder, then finished similarly to a thin sections

STEP 5: Final Lapping A finished thickness of 30 microns is achieved by lapping the section by hand on a glass plate with 600 grit carborundum. A fine grinding with 1000 grit prior to polishing is optional.

STEP 6: Polishing The section is placed in a holder and spun on a polishing machine using nylon cloth and diamond paste unitil a suitable polish is achieved for microscope or SEM studies,

STEP 7: Final inspection

by

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References

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