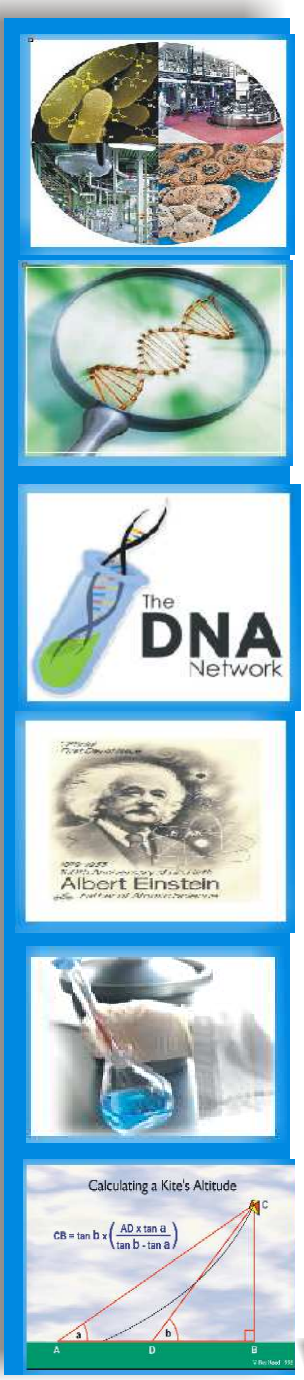

GATE - GG & GP

SAMPLE THEORY

- FOLDS AND FAULTS
- SAMPLING

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SECTION-1 (GEOLOGY)

FOLDS & FAULTS

FOLDS

A fold is represented by a curved surface or a state of curved surface whose initial curvature has been increased by deformation.

The ultimate shape and extent of a fold depends upon a number of factors like the nature, magnitude and the direction of and duration for which these forces act upon the rocks and also the nature of the rocks being affected.

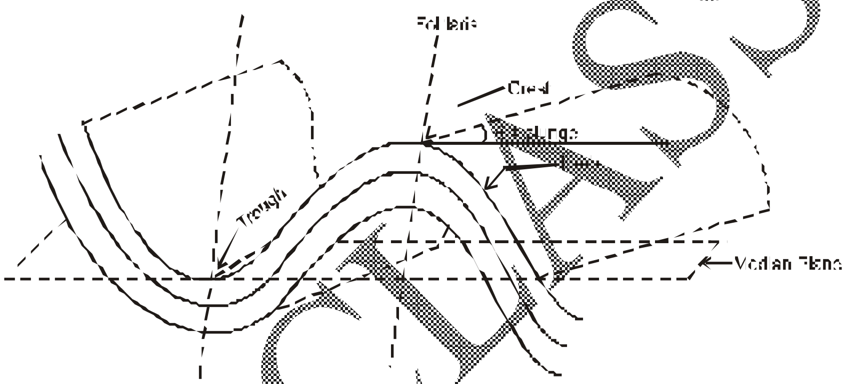

Fig.1 : Folds

The folds may develop in any type of rock and may be of any shape and geometry ranging from simple up arched bends or downward curvatures to completely overture flexures. The process of development of folds in the rocks is called Folding.

Classification of Folds

In most cases folds may be simple or complex. Folds may be classified on two basic types of folds: anticlines and synclines.

Anticlines are defined as those folds in which;

- The strata are uparched, that rocks occupy a position in the interior of the fold, oldest being positioned at the core of the fold and the youngest forming the outermost flank (provided strata show normal order of superposition), and,
- The limbs dip away from each other at the crest in the simplest cases.

Symbolically, an anticline may be indicated by two arrows diverging from the central point.

Synclines. These folds are the reverse of anticlines in all details and may be described as those folds in which;

(i) The strata are downarched, that is, these become CONVEX DOWNWARDS;

(ii) The geologically younger rocks occupy a position in the core of the fold and the older rocks from the outer flanks, provided the normal order of superposition is not disturbed.

(iii) In the simple cases in synclines, the limbs dip towards a common center.

Symbolically, a syncline may be indicated by two arrows pointing towards a central point, the hinge point.

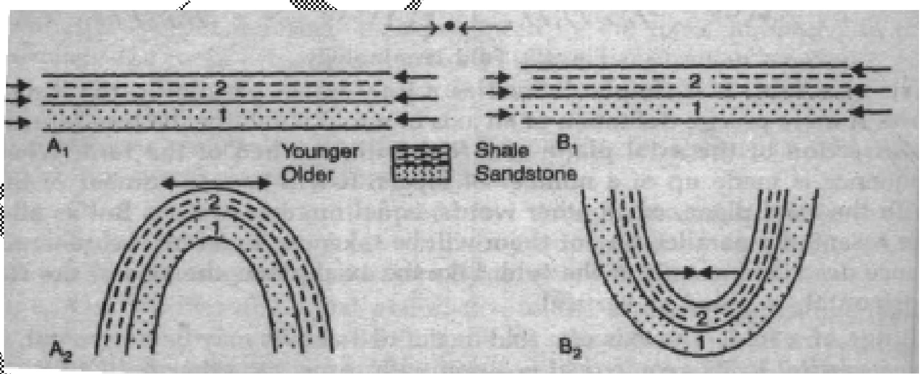

Fig.2 Anticline & Syncline (A) and (B) (strata before and after folding)

Folds are far from simple and have been variously classified on the basis of following parameters:

(i) position of the axial plane; (ii) the degree of compression;

(iii) behavior with depth; (iv) relative curvature of the outer and inner arcs;

(v) plunge of the folds; (vi) profile of the outer surface;

(vii) mode of occurrence; (vii) miscellaneous types;

FAULTS

Fracturing is favored when the stresses are shearing in nature and the rocks are brittle in character. It normally occurs when the shearing strength of the rocks is overcome by the operating shearing stresses.

Those fractures along which there has been relative movement of the blocks past each other are termed as FAULTS.

The entire process of development of fractures and displacement of the blocks against each other is termed as FAULTING.

Fault is always a crack or surface of rupture or a simple fracture surface or a zone having numerous closely spaced fractures that has to be present in the rock; it may be preexisting or may develop instantaneously just before the movement of the parts on the opposite side of the fracture takes place.

There can movement of the blocks created on either side of the fracture, the fracture will not be considered as a fault: it may be a simple fracture or a crack or a joint or a fissure.

A fault is a fracture discontinuity along which the rocks on ethers side have moved past each other. The attitude of the fault plane is expressed by its dip and strike or by its dip and dip direction. The trace of the fault on the earth's surface is the fault line.

If a fault is not vertical the side above the fault plane is called the **hanging wall** and the side below the fault plane is called the foot wall. A fault surface may be curved or planar. Curved faults are known as **Lictric fault**.

The relative displacement of two adjoining points on either side of the fault plane is known as the NET SLIP. **Net slip** is a vector which is expressed by the attitude of the line of displacement, the sense of displacement and the magnitude of displacement. The components of the net slip along the strike and dip of the fault plane are known as the **strike slip** and **dip slip** components respectively.

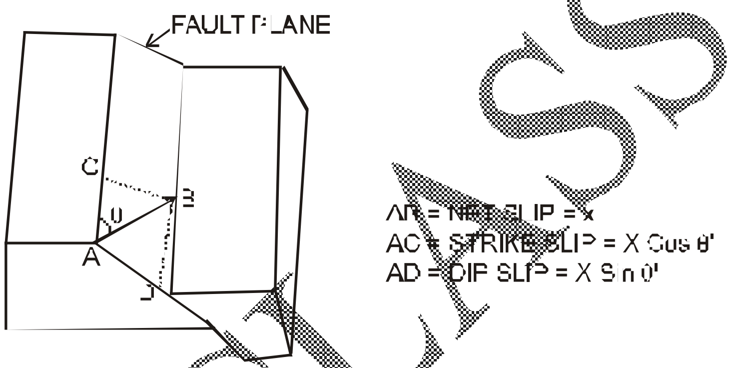

Fig. 3 Fault Plane

Dip (θ) of the fault plane is the attitude of the fault plane, may be vertical horizontal or inclined.

Hade is the (90° – θ). So

Dip + hade = 90°

Ex.1 What is the difference between shear fractures and faults?

Sol. Shear fractures are single structures, commonly referred to as surfaces but with a very small thickness (generally <1 mm). A fault is a more composite structure with a thicker zone of strongly deformed rocks (the fault core) in which there may be one or more slip surfaces. A fault also contains a damage zone of deformation bands and/or fractures where strain is much lower than in the fault core.

Ex.2 How would we identify a buckle fold?

Sol. Folding is restricted to a competent layer in a less competent matrix, with the folds rapidly dying out away from the competent layer. The folds are periodic, meaning that they have a characteristic wavelength. This characteristic wave length is longer for thick layers than for thin ones. Buckle folds are parallel (Class 1B) folds with a neutral surface.

SECTION-2 (GEOPHYSICS)

SAMPLING

In signal processing, sampling is the reduction of a continuous signal to a discrete signal. A common example is the conversion of a sound wave (a continuous signal) to a sequence of samples (a discrete-time signal).

A sample refers to a value or set of values at a point in time and/or space.

A sampler is a subsystem or operation that extracts samples from a continuous signal.

A theoretical ideal sampler produces samples equivalent to the instantaneous value of the continuous signal at the desired points.

Nyquist-Shannon sampling theorem

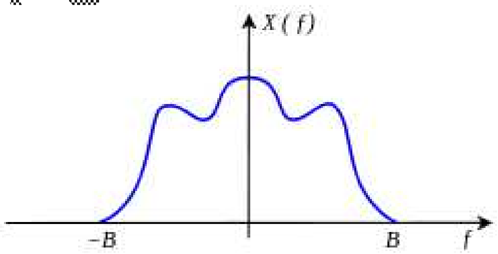

Fig. 4 Fourier transform of a bandlimited function (amplitude vs frequency)

The Nyquist-Shannon sampling theorem, is a fundamental result in the field of information theory, in particular telecommunications and signal processing.

Sampling is the process of converting a signal (for example, a function of continuous time or space) into a numeric sequence (a function of discrete time or space). Shannon's version of the theorem states:

If a function x(t) contains no frequencies higher than B hertz, it is completely determined by giving its ordinates at a series of points spaced 1/(2B) seconds apart.

In other words, a band limited function can be perfectly reconstructed from a countable sequence of samples if the band limit, B, is no greater than ½ the sampling rate (samples per second). The theorem also leads to a formula for reconstruction of the original function from its samples.

When the bandlimit is too high (or there is no bandlimit), the reconstruction exhibits imperfections known as aliasing.

Modern statements of the theorem are sometimes careful to explicitly state that x(t) must contain no sinusoidal component at exactly frequency B, or that B must be strictly less than ½ the sample rate. And the theorem does not preclude the possibility of perfect reconstruction under special circumstances that do not satisfy the sample-rate criterion. It is a sufficient, but not necessary, condition.

To formalize the statements above, let X(f) be the Fourier transform of bandlimited function x(t):

$$X(f) \stackrel{\mathrm{def}}{=} \int_{-\infty}^{\infty} x(t)\ e^{-i2\pi f t}\ \mathrm{d}t,$$ and $X(f) = 0$ for all $|f| > B.$

When x(t) is sampled uniformly at intervals of T seconds, the resultant sequence is denoted by x(nT), for all integer values of n. And the sample-rate (samples per second) is:

$$f_s \stackrel{\mathrm{def}}{=} 1/T.$$

A sufficient condition to reconstruct x(t) from its samples is $f_s > 2B$ and equivalently $B < f_s/2$. The two thresholds, and are respectively called the Nyquist rate and Nyquist frequency. And respectively, they are attributes of x(t) and of the sampling equipment.

The condition described by these inequalities is called the Nyquist criterion, or sometimes the Raabe condition.

Ex.1: Consider a sinusoid of frequency f = 10 Hz sampled at a rate of $f_S = 12$ Hz. The sampled signal will contain all the replicated frequencies 10+m12 Hz, m = 0,± 1,± 2, . . . ,

or,

$$. . . , -26, -14, -2, 10, 22, 34, 46, . . .$$

and among these only $f_a = 10 \bmod(12) = 10 - 12 = -2$ Hz lies within the Nyquist interval [–6, 6] Hz. This sinusoid will appear at the output of a reconstructor as a – 2 Hz sinusoid instead of a 10 Hz one.

On the other hand, had we sampled at a proper rate, that is, greater than 2f = 20 Hz, say at $f_S = 22$ Hz, then no aliasing would result because the given frequency of 10 Hz already lies within the corresponding Nyquist interval of [-11, 11] Hz.

Ex.2: Suppose a music piece is sampled at rate of 40 kHz without using a prefilter with cutoff of 20 kHz. Then, inaudible components having frequencies greater than 20 kHz can be aliased into the Nyquist interval [– 20, 20] distorting the true frequency components in that interval. For example, all components in the inaudible frequency range $20 \le f \le 60$ kHz will be aliased with $-20 = 20 - 40 \le f - f_S \le 60 - 40 = 20$ kHz, which are audible.