LUMINESCENCE DATING AND ITS APPLICATION

In insulator minerals, like quartz and feldspars, the conduction and valence bands are separated by a wide forbidden gap and the transition of electron from valence band to conduction bands is only possible with the aid of external force. This force is provided by environmental ionizing radiation (alpha and beta particles and gamma rays) which energises the electrons of valence band to move up to the conduction band. When these electrons loose energy, they try to drop back to conduction band and on way may be trapped in the lattice defects in the forbidden gap. When the crystal lattice is stimulated by heat or light, the trapped electrons are evicted from the traps and recombine with the holes. The recombination emits a light which is called 'Luminescence'. If exposure to radiation continues, electrons population in the traps keep on increasing until all traps are filled and saturated. This character of minerals has been used to develop the technique of luminescence dating.

The Luminescence dating is based on the fact that the old luminescence signals in minerals are reduced to zero when exposed to sunlight during erosion and transportation. When the minerals are buried, they get concealed from the daylight. The grains during burial are exposed to flux of environmental radiation and began to accumulate radiation dose in the form of newly trapped electrons. If the flux of radiation is constant, then the burial time of the grains can be determined by dividing the total dose accumulated in the grains by the dose rate, (i.e. burial time = burial dose/dose rate). In laboratory a dose equivalent to the burial dose is measured by giving a number of known radiation doses to the sample. This is referred to as the" equivalent dose or palaeodose". The dose rate arising due to decay of radioactive elements and cosmic rays is determined separately by gamma spectrometry or from the concentration of U,Th, & K in the samples. It varies with depth, altitude and water content in the samples and .grain size of the sediments.

Feldspars and quartz are the most commonly used minerals in the luminescence l dating. The choice depends on the availability of mineral and the age of sediments. Quartz saturates at lower doses than feldspars, and so the use of feldspar is advantageous for dating older deposits. However, it has a disadvantage of fading, whose rate has to be determined before final calculation.

For dating, the samples are collected in darkness in opaque aluminum/ steel tubes to protect them from light. Zones of contact, secondary calcification, bioturbations are avoided. A scaled log of the site is mandatory. The data on water table and its fluctuations are also needed.

In laboratory, the sample is processed in dim red light to separate quartz / feldspar of desired grain size after removing carbonates and organic matter. Natural and saturated water contents are also measured. Clean quartz/ felsapr grains are mounted on SS discs and palaeodose measurements are made on TL/OSL Reader following either the Single Aliqoute , Multiple Aliqoute or Single Grain technique depending upon the requirement of sample.

Measurements can be performed on sand-sized grains (100-200 micron dia), or clay-silt sized grains (4-12 micron dia.). The latter gives mixed signals of quartz and feldspar. Some pre-dating tests are carried out to understand the behavior of samples and accordingly a suitable protocol is designed to determine the palaeodose/ equivalent dose (De). About 100 discs are measured for one sample of which best ones, which follow the parametric configuration are selected. Based on the De and dose rate, final calculations for age are made. If heat is used for stimulation, the process is called thermoluminescence (TL) and if light is used it is called optically stimulation luminescence (OSL) dating.

In the last two decades, luminescence dating has become a versatile tool for dating Quaternary sediments. It has wide applicability because it can directly date the commonly occurring minerals, does not require calibrations and covers age range of few ka to 100ka.It can date sediments deposited by aeolian, fluvial, glacial, colluvial, lacustrine agencies. Primary precipitates, impactite and fault gauge can also be dated. TL dating is preferred for heated objects, while OSl is preferred for sediments because even a small exposure of the sediments to sunlight bleach the OSL traps.

OSL studies carried out at Geological Survey of India in Haryana Plains indicate that the a major fluvial system existed in the area which disappeared around 20 ka BP during Last Glacial Maximum (LGM) when the climate turned arid and dry. Subsequently, the dune accumulation started around 19 ka and continued till around 12 ka. It was followed by the deposition of fluvial/lacustrine sediments.

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