

Essay on:

AMS Fabric: A Magnetic Method of deciphering Sediment flow axis

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“Men in his ventures has progressed forward taking brisk steps. Ahead as he goes, walking all the way, he confronts newer pathways and unravels newer dimensions. But stop there human! Beware! Let your steps be brisk; you are determined to conquer the world, but let your steps fall on the right soil”

Introduction

The study of the earth has captured the interest and imagination of people throughout the ages. The desire to experience and understand earth's environments has pushed the frontiers of humankind's exploration across the entire globe and beyond, to earth's moon and to other planets. Remarkable discoveries from space exploration have been matched in our knowledge of deep ocean environments and the interior of the earth. The driving force has been a deep human curiosity about our physical environment, joined with a need to test hypothesis, to unravel earth's history, and to gain insights into the formation of our solar system and the universe of which earth is just a small part.

All minerals have magnetic susceptibility ranging from weak negative diamagnetism in many silicates to stronger positive paramagnetism in other silicates (usually iron bearing) including strong ferromagnetism in certain oxides and sulphides. In isotropic material there is no variation in total susceptibility with direction indicating a random orientation of minerals. The minerals often have an inherent shape and/or crystalline anisotropy. The geological processes like flowage, straining etc. tend to produce preferential orientation of grains giving variation in susceptibility with direction. Any variation in magnetic susceptibility with orientation results into Anisotropy of Magnetic Susceptibility (AMS). In general, the term magnetic anisotropy refers to the directional variability in magnetization.

The magnetic fabric technique is the is a well-established approach for defining the orientation of sedimentary grains in three dimensions. The technique is based on the dependence of Anisotropy of Magnetic Susceptibility (AMS) on the alignment of the long and short axes of magnetic mineral grains within the sediment. The magnetic susceptibility, k , is the ratio of the induced magnetization in a substance to the applied magnetic field and it varies with direction within a single magnetic grain as a result of the grain's shape and crystalline properties. This variation can be represented by a triaxial ellipsoid, with the principal axes corresponding to the maximum (K_{\max}), intermediate (k_{int}) and

minimum (k_{\min}) susceptibility axes, respectively. Thus the AMS of a single magnetic grain, the (K_{\max}), axis coinciding with the long axis of the grain and the (k_{\min}) axis with the short axis of the grain.

It has been observed that the preferred alignment of the magnetic mineral grains appear to be closely parallel that of the nonmagnetic mineral grains in the same sample. As the magnetic susceptibility of Magnetite, (a common carrier of magnetic susceptibility in sedimentary rocks) is much greater than that of the other natural iron oxides, this mineral will dominate the AMS, it is present in very small amounts. In the absence of the Magnetite, the AMS will reflect the preferred orientation of other iron oxides and/or paramagnetic minerals such as clay minerals. For an assemblage of magnetic grains within a non-ferromagnetic matrix in a sediment sample, the AMS of the sample as a whole will reflect the preferred alignment of the population of the magnetic grains. Here, the (K_{\max}) axis represents the direction of preferred orientation of the grain long axis and the (k_{\min}) axis that of the grain short axes within the sediments. Therefore measurement of the AMS of the sample then provide a rapid, cost effective and non-destructive method for specifying the preferred orientation of the constituent grains. Unless disturbed, a sedimentary grain fabric reflects the physical conditions at the time of deposition. The purpose of AMS

study in sediments is to obtain some information on the deposition process of ferromagnetic grains.

Magnetic anisotropy has been used many times in the investigations of paleocurrents in sedimentary basins. It has been observed that the current directions deduced from the external sedimentary structures like sole marks, flute casts, groove casts and the internal sedimentary structures like current beddings, current ripple laminations, symmetrical and asymmetrical ripples accord well with the AMS fabric directions. Minimum susceptibility direction has been found to be parallel to the current flow direction.

The excellent agreement in the sediment transport direction by the present magnetic fabric investigations gives a clear demonstration of the success of AMS technique and it holds enormous potential to decipher the possible sediments source and paleoflow direction in other sedimentary basins. Also in sedimentary basins where paleocurrent data are not available, this AMS technique can be a very reliable and handy tool to decipher the sediment flow direction.

References:

Patil and Mullick, Indian Institute of Remote Sensing;

Journals by Dr. A.K. Biyani