independent of a priori assumptions about Z and can be interpreted in terms of three-dimensional conductivity structures. Through SVD, the impedance is represented by two characteristic states. These states consist of two pairs (E and H) of complex vectors and two corresponding, real, singular values which together describe the extremal properties of Z. The singular values are the maximum and minimum $|E|/|H|$ ratios possible at the observation site and therefore yield the true maximum and minimum apparent resistivities.

We use a variation of SVD analysis by incorporating phases in the singular values, which are then called characteristic values. These phases reflect the delay (caused by the earth's conductivity) of the electric fields relative to their associated magnetic field. In this analysis of Z, the characteristic values contain four parameters, two singular values and two phases. The characteristic vectors contain the remaining four parameters, two principal axis directions and two ellipticities. The principal axis directions for the E and H vectors need not be at right angles as in biorthogonal analysis. The deviation of these axes from orthogonality is called the "skew angle" S. From a model by Park, we have found S to be closely related to distortions in the telluric current system caused by current gathering due to a good conductor. From the same model, we have found the ellipticity parameters to be the largest in regions of high current distortion and at the shorter periods. Consequently, we speculate that the ellipticity parameters are associated with local induction.
GEOPHYSICS, VOL. 51, NO. 9

Polymetallic Sulfide Exploration on the Deep Sea Floor: The Feasibility of the MINI-MOSES Experiment

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The recent discoveries of polymetallic sulfide deposits on the deep sea floor have created an interest in geophysical techniques for mapping them. A Magnetometric resistivity method (MINI-MOSES) has been developed for detecting the distribution of sub-sea-floor electrical resistivity. A vertical, long-wire bipole feeds electric current into the ocean. Some of the current enters the sea floor, and its magnetic field is measured at various distances by a low-frequency induction coil magnetometer. The method is sensitive to conductive and resistive zones at depth, and information about three-dimensional resistivity structures can be obtained.

The small load resistance of an electric transmitter grounded in the ocean allows high current to be driven by a battery-powered instrument. The induction coil receiver is more sensitive and less noisy than conventional flux-gate magnetometers over the selected frequency band. This receiver is therefore well-adapted to the almost noise-free deep sea-floor environment. Both the transmitter and the receiver are completely self-contained, recording averaged transmitted and received signals in random access memory.

The technique was tested near a sulfide deposit at 47°57'N, 129°06'W on the axis of the Juan de Fuca Ridge. The deep submersible ALVIN positioned and moved the instruments about on the sea floor. Just enough data were obtained to demonstrate the viability of the technique for this kind of geologic mapping and mineral exploration. The electrical resistivity of 14 Ω·m obtained for a uniform half-space model is consistent with Deep Sea Drilling Project (DSDP) results for the seawater-saturated basalt.
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Geomagnetism and Paleomagnetism

1525 Paleomagnetism applied to tectonics
PALEOMAGNETISM OF CRETACEOUS AND EOCENE STRATA, SAN MIGUEL ISLAND, CALIFORNIA BORDERLAND AND THE NORTHWARD TRANSLATION OF BAJA CALIFORNIA
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The history of poleward motion of the Baja California peninsula is a subject of continuing geologic investigations, including paleomagnetic studies during the past decade. Geologic correlations seem not to necessitate northward movement, while paleomagnetic data suggest movement of 1000 km or more. We have made paleomagnetic measurements on Cretaceous and Eocene sedimentary rocks of San Miguel Island, California, which are western lithofacies of rocks cropping out on the Baja peninsula. A total of 97 drill cores taken from Upper Cretaceous turbidites, though weakly magnetized, were found to clean best in response to thermal demagnetization. This direction is 19° shallower and rotated 50° clockwise from the expected direction for the present site position, and corresponds to a paleolatitude of 26°N. A total of 117 drill cores of middle Eocene rocks revealed characteristic magnetizations in response to either alternating field or thermal demagnetizations. A mean direction of magnetization can be derived from the intersection of planes fitted to the paths of demagnetization. This direction is 24° shallower and rotated 79° clockwise from the expected Eocene direction for this site, and corresponds to a latitude of 17°N. These paleomagnetic data in combination with recently published data for the Baja peninsula and Peninsular Ranges of southern California, indicate motion trajectories that mimic the North American craton for the period Cretaceous to late Eocene time. During the Oligocene the Baja peninsula and adjoining regions to the west moved northward relative to the craton arriving at a pre-Gulf of California position not later than earliest Miocene time. A comparison of the northward motion of the Baja peninsula with that of the Santa Lucia-Orocopia allochthon shows that both area underwent rapid poleward translations, but these motions occurred at different times.

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1525 Paleomagnetism applied to tectonics
STRAIN REORIENTATION OF HEMATITE AND ITS BEARING UPON REMANENT MAGNETIZATION
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Using a computer-based numerical model, we suggest that passive reorientation of hematite planar particles induced by strain perturb significantly the remanent magnetization carried by the hematite. The evolution of its direction and dispersion in a progressively increasing strain can be correlated with the evolution of passive lines. In real rocks, the amount of reorientation can be approched by measuring one of the three following tensors: strain tensor, orientation tensor of some hematite cristallographic axes, or magnetic susceptibility tensor. From examples taken in the Maritime Alps and in Brittany, we emphasize the possible correlations between these tensors (orientation of principal axes and axial ratios). Finally, we use our best estimate of strain to correct the paleomagnetic results by the strain removal technique we have already used in the Maritime Alps (Cogné and Perroud, 1985). When applied to the preliminary paleomagnetic results obtained from Ordovician deformed redbeds of Brittany, it allows to recover a conclusive primary magnetization direction, although the characteristic magnetizations appear post-folding with respect to the classical fold test. (Texture goniometry, anisotropy of the magnetic susceptibility, paleomagnetism, strain removal.)

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Hydrology

1830 Groundwater
CHLORINE-36 DATING OF VERY OLD GROUNDWATER II. MILK RIVER AQUIFER, ALBERTA, CANADA
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The Milk River aquifer in southern Alberta, Canada, consists of sandstone interbedded between thick shale units. The ground-water is confined and discharges by both upward and downward leakage through the shales. The concentration of Cl^- increases by about 2 orders of magnitude downgradient through the aquifer. This Cl^- increase complicates ^{36}Cl dating of the system. Climatic changes, flushing of connate water, introduction of Cl^- from older water below the aquifer, and ion filtration have been proposed as possible explanations for the increase. The ^{36}Cl data show a consistent decrease of the $^{36}Cl/Cl$ ratio downgradient, but an increase in the ^{36}Cl concentration down gradient in certain parts of the aquifer. Dates calculated from the $^{36}Cl/Cl$ ratio show a reasonable distribution in light of the hydraulic controls on the system, whereas dates calculated from the ^{36}Cl concentration give negative ages. This suggests that ion filtration is responsible for the Cl^- increase and that the $^{36}Cl/Cl$ dates are to be preferred. We estimate water ages to be more than 2 Myr near the distal end of the aquifer. (Groundwater, radiometric dating, ion filtration, chlorine-36.)

Water Resour. Res., Paper 6W4353

1839 Infiltration
LINEARIZED UNSTEADY MULTIDIMENSIONAL INFILTRATION
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The parameters in the linearized multidimensional unsteady equation for unsaturated flow in homogeneous soils can be chosen so that small time flow rates are given correctly, with the quasilinear steady solution as the large time limit. Matched thus, the linearized equation offers insight into the time course of multidimensional infiltration. The Laplace transform reduces the equation and its governing conditions into forms similar to those for quasilinear steady flows. The problems of unsteady infiltration from buried spherical and cylindrical cavities are solved. Frequently the solutions are approximately reducible to the product of the steady solution and a function only of time and radial coordinate. Theorems show that approximate product solutions apply not only to these configurations, but to multidimensional cavities of arbitrary shape. Multidimensional infiltration from finite supply surfaces involves two characteristic times, one deriving from the capillarity-gravity interaction and the other from the capillarity-geometry interaction. We explore the influence of these two times on the time scales of approach to steady moisture distribution near the supply surface and to steady discharge. The analysis provides explanation of the relatively rapid approach to the steady state observed in three-dimensional infiltration from small supply surfaces. (Unsaturated flow, subirrigation, field permeameters.)

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