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COMPUTER CORRELATION OF GEOPHYSICAL LOGS

Interpretation of subsurface geology commonly depends on correlation of geophysical logs. In its simplest form, the process of correlation involves visual matching of similar characteristics on several logs. In regions where strata do not thicken or thin, correlation simply involves shifting one of the logs relative to the other until common characteristics are aligned. Variations in strata thickness, however, complicate the procedure and emphasize a need for computer analysis.

Automatic correlation of logs by computer techniques depends on utilizing the mathematical concept of a cross-correlation function. Position of the maximum value of the function identifies the amount of shift. Correlation of logs with varying thicknesses of strata involves a 2-step process. First, 1 log is resampled mathematically at an expanded or stretched interval, and then the stretched log is used in the cross-correlation process.

Models simulating geophysical logs demonstrate computer capability to compute shift and stretch. Computer output consists of a plotted reproduction of 2 logs with correlation lines connecting similar strata in each log. Applications to real well data in Indiana support visual correlations suggested by subsurface stratigraphers. Copies of the computer program can be obtained from the Indiana Geological Survey.

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NAVIGATION, FIELD OPERATION, AND IMAGE-PROCESSING TECHNIQUES FOR THERMAL INFRARED IMAGERY SURVEYS

Numerous reports have demonstrated the applicability of thermal infrared imagery surveys to geologic, environmental, and agricultural problems.

Most thermal infrared imaging for geologic purposes is flown at night to avoid the effects of differential solar heating. Existing aeronautical navigation aids are designed for point-to-point flights rather than the precisely spaced and oriented parallel flight lines required to cover a project area. The traditional method of navigating nighttime imagery flights requires personnel with signal lights to occupy a sequence of ground control points and this method has numerous drawbacks.

A newly developed aircraft navigation system utilizes the 9 very low-frequency U.S. Navy radio transmitters located around the globe to fly very accurate courses with no ground aids. Using this system at night to navigate from the base air strip to a known starting point within the project area, parallel survey lines up to 50 mi long have been flown with precise spacing to obtain the necessary imagery sidelap for preparing mosaics. Comparison of actual aircraft flight lines (obtained by plotting nadir line of imagery onto a map) with the programmed flight lines indicates a satisfactory agreement. The navigation system also provides real-time readout of true ground speed which is essential for processing of imagery magnetic tapes.

After solving the navigation problems, the flight program is designed. Each project area has unique combinations of terrain and geology that require special consideration, but some generally valid concepts have been established. Normally the orientation of the structural grain of an area is known before the survey. Flight lines should not cross the structural grain at right angles because subtle linear patterns may be obscured by the closely spaced scan lines on the imagery. Selection of flight altitude above average terrain elevation is a tradeoff between imagery spatial resolution versus imagery scale and ground coverage. Cost is also a factor, for at higher flight altitudes the ground coverage is greater and fewer flight lines are required. Atmospheric attenuation of the infrared signal at higher flight altitudes must also be considered. As a practical guide to altitude selection, imagery of the same flight line at altitudes ranging from 1,000 to 8,000 ft above terrain is shown.

Thermal infrared imagery has been improved greatly by recent advances in electro-optical technology and solid-state physics. Doped germanium detectors which required closed cycle cryostats or liquid helium cooling have been replaced with tri-metal detectors which operate with simple liquid nitrogen cooling to obtain imagery in the 8–14 micrometer wavelength region of greatest geologic significance. Quantitative scanners are now available in which gray-scale variations are calibrated to exact temperature values rather than relative temperature variations.

Early airborne scanners which recorded imagery directly on film had many disadvantages. Modern scanners record the imagery on magnetic tape which is later played back onto film in the laboratory. The magnetic tape may be replayed to obtain optimum imagery contrast and to adjust the scale for any variations in aircraft ground speed. Conventional scanner imagery is compressed and distorted at the margins because of the geometry of the system. The magnetic tapes, however, may be processed with a secant-square function to produce rectilinearized imagery with constant scales in the X and Y directions. Various image enhancement techniques also may be applied to the tapes, such as level slicing, digitizing, and conversion to color display for greater resolution of subtle thermal differences.

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DIAGENETIC CHANGES IN ULTRASTRUCTURE OF SKELETAL CARBONATES FROM PLEISTOCENE OF SOUTH FLORIDA

Scanning electron micrographs of skeletal carbonates (mollusks, corals, barnacles, polychaete annelids, bryozoans) from the Miami and Key Largo Limestones (south Florida) provide unequivocal evidence for *in situ* conversion of skeletal aragonites. Many of the petrographic criteria for such conversion have been regarded as uncertain; presence of inclusions reflecting former skeletal structures is more reliable evidence of direct conversion than solution-infill mosaics. In converted aragonites, coarse calcite mosaics contain submicroscopic remnant crystallites of the original aragonitic ultrastructure. These remnant crystallites are in original orientation, as solid inclusions in the calcite grains. Partially altered shells traversed by advancing diagenetic fronts demonstrate the continuity of orientation of the crystallites in the unaltered aragonitic shell layers with the aragonitic solid inclusions in the calcite mosaic behind the front. Mineralogy of the respective grains and crystallites was verified by means of Feigl solution, an aragonite-specific stain.

Calcite ultrastructures are commonly little affected, but in *Schizoporella floridana* (Bryozoa) from the Miami Limestone, the calcitic primary skeleton is recrys-