

proach, Example from West El Reno Field, Canadian County, Oklahoma

The Frisco Formation is a middle Lower Devonian limestone within the Hunton Group (Upper Ordovician-Lower Devonian). In the Anadarko basin, the Frisco Formation consists of skeletal packstones and grainstones, whose main components are pelmatozoans, brachiopods, and, locally, corals. Depositional intergranular porosity has been mostly obliterated through syntaxial cementation on pelmatozoans, and mechanical and chemical compaction. Only minor intra-bryozoan primary porosity remains. Secondary porosity, which formed during subaerial exposure of the Frisco Formation during the late Early and Middle Devonian, occurs locally at the top of the formation in the form of partly leached grains, vugs, and solution channels. This secondary porosity is best developed close to areas where the formation was completely eroded; these areas commonly correspond to Middle Devonian paleostructures.

Hydrocarbon accumulations in the Frisco Formation are mainly in stratigraphic traps situated downdip of the areas where the formation has been severely truncated. The Woodford Shale (Upper Devonian-Lower Mississippian) unconformably overlies the Frisco Formation in the study area and provides a source, trap, and seal for Frisco Formation reservoirs.

Geophysical identification of Frisco Formation porosity is possible using Relative Amplitude (RAM) processing. Mapping of porosity and truncated margins, and identification of potential hydrocarbon traps, are facilitated by using these RAM processed seismic sections. The West El Reno field, Canadian County, Oklahoma, produces gas and condensate from an outlier of the Frisco Formation, and provides a template for this technique.

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Overview of LASL Oil Shale Program

The Los Alamos Scientific Laboratory (LASL) is involved in a broad spectrum of oil shale-related activities for the Department of Energy (DOE), including the bed preparation design of a modified in-situ retort. This aspect of oil shale research has been identified by the DOE as one of the limiting technologies impeding commercial, in-situ development of oil shale.

The retort bed must have uniform particle size, permeability, and void distributions to allow proper retorting and optimum resource recovery. Controlled fracturing using chemical explosives and carefully designed blasting schemes are the only feasible methods to attain this distribution. Our approach to the bed preparation problem is a coordinated research program of explosives characterization, dynamic rock mechanics, predictive computer modeling, and field verification tests.

The program is designed to develop the predictive fracturing capability required for the optimum rubble of the shale. It takes advantage of the large computing facilities at Los Alamos and the considerable expertise in explosives and computer hydrocodes developed here for other energy and national defense programs. As these codes are developed for oil shale and refined, they are tested with field verification experiments. Tests with up to four boreholes and single-decked charges conducted at the Colony Mine in Colorado in conjunction with ARCO and TOSCO, have demonstrated the ability to predict rock behavior. Larger experiments with more boreholes and decked charges will be done at the Anvil Points Mine near Rifle, Colorado. These field tests will calibrate the fracture modeling codes and confirm their validity to predict explosive

fracturing, including the effects of existing joints and fractures in the oil shale. The experiments will also include fluid flow tests to verify the three-dimensional models of multiphase flow that are under development at LASL.

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Mineral Exploration Using Landsat Image Processing and Interpretation Techniques

Custom-processed, enhanced Landsat images were produced to support mineral exploration and resources mapping programs in: (1) the Marfa basin of west Texas, and (2) Puerto Rico. The objective of these projects was to map surface geologic features from the images to aid in geologic analysis of mineral potential.

Contrast-stretched false color images and high-pass filter images ranging in scale from 1:125,000 to 1:250,000 were made for both areas. Through interpretation, a variety of features (linears, curvilinears, drainage patterns, lithology, etc) were successfully mapped. A significant amount of new information was collected (e.g., 30% more linears were mapped in west Texas).

Due to the semi-arid nature of west Texas, techniques that exaggerate spectral differences of the land surface as sensed by the satellite, were used to aid in mapping rock units. A series of ratio images was made to enhance iron oxides, a potential indicator of mineralization in this area. Extensive field work and spectral radiometer studies were used to evaluate initial results and collect data to permit more effective image processing. Ratio images of the visual green and visual red spectral bands proved highly effective for mapping iron oxides.

Due to its synoptic, regional view and effectiveness for mapping a variety of surface geologic features, Landsat image processing and interpretation can provide significant new information that is especially useful in the reconnaissance stages of exploration. When used in conjunction with other data sources and geologic analysis, Landsat can improve exploration programs.

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Paleogeography and Tectonic Implications of Late Cretaceous to Middle Tertiary Rocks of Southern Denver Basin, Colorado

In the southwestern Denver basin, the lower part of the Dawson Formation consists of point-bar sequences composed of andesitic detritus. Eastward, it thickens and becomes predominantly mudstone with subordinate thin point bars. The upper Dawson consists of a basal, eastward-thinning, wedge of feldspathic (braided stream) conglomerates followed by feldspathic or andesitic point-bar deposits, overlain by braided-stream arkoses. Dawson cross-bedding dips eastward. During lower Dawson deposition, the Front Range is interpreted to have only minor topographic expression because andesitic debris came from a source west of the Front Range and was deposited in meandering streams. Early Paleocene erosion of the first Laramide exposure of the Front Range basement produced the lower arkosic unit. Following meandering-stream deposition, a second major arkosic pulse of coarse braided-stream deposits prograded eastward (late Paleocene-early Eocene). Extensive Eocene erosion and stability followed until the Oligocene when the extensive Wall