pounds (221,000 bbl) from a chlor-alkali plant, associated with previously injected wastes (874,000 bbl) from production of the herbidices 2, 4-D, and MCPA.

The depths of injection intervals range from 1,448 to 4,692 ft. The maximum total depth of a disposal well in Saskatchewan is 5,536 ft. Average injection rates are from 3 to 1,100 US gpm and average wellhead pressures vary from the sole influence of gravity to 1,750 psig. More than 44.13% of all industrial wastes injected into the Saskatchewan subsurface are received by clastic aquifers. In 18 injection systems, clastic units (Cambrian and Ordovician; Lower Cretaceous) are the disposal intervals, whereas 13 wells have been completed for disposal into carbonate units (Silurian to Mississippian). There are four multizone completions, each involving disposal of potash brines into a Silurian carbonate aquifer and an Ordovician clastic aquifer. In three disposal systems, mercury compounds are permitted to accumulate in caverns in Devonian evaporite strata.

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ANALYSIS OF ENERGY CRUNCH AND APPLICATION OF COMPUTER TECHNIQUES TO SEARCH FOR OIL AND GAS

No abstract available.

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COMPARISON OF RECENT LABORATORY MODELS TO NATURAL DEFORMATION IN ROCKY MOUNTAIN FORELANDS

Several years ago for the first time the technique for experimental folding of layered real rocks under conditions expected within sedimentary basins was developed in our laboratory. In the initial experiments the samples had to be loaded parallel with the layering simulating horizontal compression. Though these experiments produced many insights into the overall folding process, they are not representative of most folds in the Rocky Mountain forelands where the folds result from differential vertical movements of the basement. However, within the last year the technique has been modified to produce loads at high angles to the layering and now we can produce a form of drape folding that does, indeed, have much in common with folds in the Rocky Mountain foreland. Making one-to-one correlations of simplified laboratory experiments to complicated natural features can be fraught with danger and completely misleading. However, these experiments verify so many long suspected natural phenomena that selected comparisons may be significant.

Scale alone precludes complete observation of natural folds with thousands of feet of displacement, but if correlations to experimentally created folds can be validated, the overall fold process becomes subject to direct observation. Such observations lead to increased confidence in delineation of structural geometries on the natural scale. This is especially true for the more complicated fold forms that usually have to be predicted in the subsurface from limited exploration data. It is gratifying to see that the overall movements in the experiment correlate well with natural folds, because it allows us to develop conceptual models upon which we can draw when dealing with widespread subsurface control or masked seismic data.

THOMAIDIS, N. D., Mountain Fuel Supply Co., Salt Lake City, Utah

CHURCH BUTTES ARCH, WYOMING AND UTAH

The Church Buttes arch extends from the Bridger Lake field in northern Utah northward through the Church Buttes field to the Big Piney-LaBarge field in southwestern Wyoming, a distance of approximately 120 mi. The arch is considered an overthrust structure. Deformation of the Absaroka thrust zone and the Church Buttes arch occurred during the Late Cretaceous as the result of the same tectonic forces. Folding of the arch resulted in localization of oil and gas accumulations in Mesozoic and Paleozoic rocks. Oil and gas production from combination structural-stratigraphic traps, directly related to the folding of the arch, has been established in the Cretaceous Frontier, Bear River, and Dakota Formations, and the Pennsylvanian Morgan Formation. Continued exploration of the arch should result in additional discoveries in both Mesozoic and Paleozoic rocks.

WOLD, JOHN, Independent Geologist, Casper, Wyo.

WESTERN COAL—CLEAN BLACK ACE IN THE HOLE

In 1973 oil and gas supplied 77% of America's energy, 19% came from coal, less than 5% from nuclear, hydroelectric, and other sources.

Oil and gas make up only 9% of our domestic fossil fuel reserves. Oil shale accounts for 15% and coal 74%. For a nation facing future energy shortages, this arithmetic should tell a story. Sixty-four percent of our domestic coal reserves are in the Dakotas and Rocky Mountain States.

Barely 10 years ago the major oil companies first started a programmed acquisition of western coal resources for the synthetic fuel-from-coal industry. The recent dramatic changes in the price structure of U.S. fossil fuels now make synthetic gas and liquids from coal competitive with traditional supplies.

Coal is not difficult to find. The geology of coal in the western basins is generally simple. Western coal's problems have been geography, economics, and politics.

About 80% of western coal lies under the public domain. Indecision and politics have resulted in a three-year freeze on Federal coal leasing. This has slowed down the timetable for western coal's contribution to the national energy mix.

Western coal's assets are low mining costs and low sulphur. Present resource acquisitions are almost exclusively strippable deposits. Nevertheless, only about 5% of western coal can be surface mined economically with present equipment. The real future may well lie in the development of techniques to mine clean energy from the 95% of the coal reserves which are underground.

For instance, a tract of land 10 mi long and 5 mi wide in the Powder River basin of Wyoming contains more coal Btu's at a depth of 1,000-2,000 ft than all the known oil reserves in the U.S.—onshore, offshore, and the North Slope of Alaska. Herein may be the challenge and the biggest opportunities. For an

energy-short nation, western coal can be the "Clean Black Ace in the Hole."

SEPM Abstracts of Papers

BILBEY, SUE ANN, Univ. Utah, Salt Lake City, Utah

PETROLOGY OF MORRISON FORMATION, DINOSAUR QUARRY, UTAH

No abstract available.

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MANNVILLE (LOWER CRETACEOUS) BASIN OF SOUTHWESTERN SASKATCHEWAN

The Mannville Group is represented by the Success (new name), Cantuar, and Pense Formations. The Success Formation, Neocomian in age and lying on a low relief unconformity across the Swift Current region, is dominated by sandstones of quartz and kaolinite with accessory chert and spherosiderite. A bipartite lacustrine to fluviatile succession, the Success Formation is correlated with the upper Morrison and the Lakota sandstone of central Montana. Its provenance is deduced to have been the Precambrian shield. The tripartite Cantuar Formation lies on a high-relief unconformity that dissects the Success and all Jurassic strata in the area. At the base of the pre-Cantuar relief is the McCloud Member (new name). It is composed largely of autochthonous sandstones overlain by an estuarine to marine shale that reaches southward from east-central Alberta to the international border in Saskatchewan as ria-like fingers of the marine Ellerslie Formation. The member is Aptian in age, is correlated with the Third Cat Creek and Cut Bank sandstones of the Kootenai of Montana, and with the Success Formation, is correlated with the lower Mannville of Alberta. The Albian Dimmock Creek and Atlas Members (new name), by virtue of their chlorite and biotite content, constitute the green feldspathic facies of the Mannville and Kootenai that are distributed across southern Saskatchewan from the Rocky Mountains of southwestern Alberta. Fluviatile to deltaic-marine, these deposits were laid down on sedimentation surfaces that progressively encroached upon and largely buried the pre-Mannville topography. The Pense Formation is entirely marine and is composed of four units represented in general by (1) basal black shales, (2) dark gray and black bioturbated sandy mudstones, and (3) well-sorted, bedded and crossbedded, fine to medium calcareous sandstones. The last are thought to have formed under wave conditions as a culmination of sediment buildup on the crown of the submerged Swift Current platform prior to renewed foundering of the platform. The Pense sandstones grade into the silts and black shales at the base of the Colorado Group in central Montana.

Locally, sedimentation was controlled by episodic uplift of the Swift Current platform from the Middle Jurassic Shaunavon basin. This uplift began during the Late Jurassic and reached a climax (500-700 ft) during the earliest Cantuar, but continued into post-Cantuar-pre-Pense times. Now, the platform forms the broad structural keel of southern Saskatchewan, having down-tilted about 1,600 ft from its early Cantuar elevations. Its mass is furrowed by valley sinks and punctuated with knobs created by the episodic dissolution of salt from the Middle Devonian Prairie Evaporite.

The oil reservoirs occupy the northwestern updip edge of the Roseray and Success Formations and lie in mesas enveloped by Cantuar argillaceous valley fill. The oil reservoirs are also under the influence of a massive high-pressure potentiometric cell and its subsidiaries on the west, that are pressurized by the upwelling of waters from the Paleozoic limestones through a regional linear zone of structural weakness. The easterly to southeasterly downdip flow through the Cantuar semipermeable barriers acts to enlarge the trapping capacity of the reservoirs. Oil prospects lie in unlocated Roseray and Success mesas, and structural highs in general. Other prospects are associated with permeable sandstones of the upper Mannville beds, as well as channel sandstones of the McCloud Member. Gas prospects in addition are found in the updip edge of the Pense Formation.

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PRIMARY AND SECONDARY SEDIMENTARY STRUCTURES IN FINE-GRAINED LACUSTRINE ROCKS OF GREEN RIVER FORMATION (EOCENE), PICEANCE CREEK BASIN, COLORADO

A study of 285 polished slabs (59.0% oil shale, 23.0% carbonate, and 18.0% fine-grained clastic rock) collected from four measured sections along the southern and eastern edge of the Piceance basin reveals important sedimentologic information on the distribution of primary and secondary sedimentary structures. The slabs were studied under low-power binocular magnification, and individual stratification characteristics were noted. A total of 528 primary structures and 334 secondary structures were observed in the slabs.

Eleven descriptive classes of primary structures are important: (1) even parallel stratification; (2) discontinuous even parallel stratification; (3) wavy parallel and nonparallel stratification; (4) discontinuous wavy parallel and nonparallel stratification; (5) discontinuous curved parallel stratification; (6) curved nonparallel stratification; (7) structureless; (8) mottled; (9) brecciated; (10) algal stratification; and (11) graded stratification. Of these classes, the oil shale is dominated by classes 1, 2, 3, and 4, and the carbonate and fine-grained clastic rocks by classes 6, 7, 8, and 10. Classes 5 and 9 are rarely represented.

Apparently there is a correlation between the organic content and the stratification type of the oil shale. As oil shale increases in organic content, classes 2 and 4 become more abundant and classes 1 and 3 are less so. In the oil shale of the Parachute Creek Member of the two easternmost measured sections, class 1 decreases, whereas classes 2 and 4 increase upward through the sections. The older classes remain approximately the same. These vertical changes correlate with indications of desiccation in the depositional environment in the upper parts of the Parachute Creek Member.

Six classes of secondary sedimentary structures are common: (1) loop structure; (2) fault displacement; (3) crystal-growth displacement; (4) bioturbation; (5) contortion; and (6) total disruption. Most of these classes are restricted to oil shale, and loop, fault and crystal-growth types are most abundant. The frequency