These include the Dilco coal which rests on the Dalton Sandstone, and the Cleary coal which overlies the widely distributed Point Look Sandstone. Menefee and Kirtland-Fruitland coals are commonly associated with discontinuous sandstones of limited ground-water potential.

Much of the natural ground water associated with the coal deposits of the San Juan basin does not meet the water-quality standards of the Public Health Service or the Office of Surface Mining. However, to prevent further degradation, stripping and reclamation practices should be based on the regional hydrologic system and on the hydrologic characteristics of the coal-associated aquifers.

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Response of Rio Grande River to Dam Construction

Data in sufficient detail to support a qualitative assessment of the geomorphic response of the Rio Grande to the construction of main-stem dams are available for two reaches in New Mexico: below Elephant Butte Dam and below Cochiti Dam. Documentation of channel adjustments below Elephant Butte Dam during 1917-32 provides a set of interpretive keys to support a detailed analysis of the response of the Rio Grande to the construction of Cochiti Dam in 1973. A comparison of cross-section, planform, and profile data develops a time-sequenced picture of geomorphic change during 1970-80 in the 50-mi (80 km) reach of the Rio Grande below Cochiti. When correlated with the hydrologic records, hydraulic data, and the history of engineering activity in the reach this analysis provides a qualitative assessment, in terms of trends, of the response of a semiarid zone alluvial river to dam construction.

Regulation of discharge and alternation of sediment load following closure of Cochiti Dam required major adjustments in the alluvial system below the dam. In the upper reaches, gravel armor and base-level control by the volume and size of sediment in arroyo and tributary deltas restricted change in the vertical dimension. Correlative adjustment in river planform was strongly influenced by channelization activities. In the lower reaches, adjustment has been through significant shifts in longitudinal profile with relatively little change in planform. Degradation was limited by gravel armor and arroyo control in the upper reaches, but became the dominant process in the middle reaches. In the lower reaches, an initial period of degradation was followed by aggradation as the heavy sediment load derived from upstream scour encountered a slightly reduced gradient and depletion of main channel flow by successive irrigation diversions. Available hydrologic data also permit evaluation of the impact of an extended period of regulated low flow and a sustained period of high flow on system stability.

A qualitative analysis, alone, yields meaningful results, and also supports a more precise assessment of river response as well as the predictive capability that can be derived from physical-process computer modeling.

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Environment of Deposition and Uranium Host Rock Potential of Jurassic Morrison Formation, Northeastern New Mexico

A stratigraphic examination of the Morrison Formation in northeastern New Mexico indicates that its sediments were deposited in either a semiarid or arid environment when the area was located below 30°N lat. and was under the influence of the Northeast Trades. The dry environment and the prevailing northeasterly flow adversely affected the chance of commercial quantities of uranium from being incorporated into Morrison sediments.

Dinosaurs that lived in the area were adapted to living in a dry and hot habitat.

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Preliminary Basin Analysis of El Rito Formation (Eocene), North-Central New Mexico

The Eocene El Rito Formation of north-central New Mexico is the basal Tertiary unit of the Chama basin and the northwestern Espanola basin. Deposition of the El Rito occurred in the final stages of the Laramide orogeny. The formation is an alluvial-fan deposit, showing two principal facies, quartzite conglomerate and quartzose sandstone. Paleocurrent directions determined from imbricated clasts, cross-bedding, and parting lineations indicate that the primary sources for the sediment were in the north and northeast.

The clasts of the early, conglomeratic facies were derived from the reworking of sediments eroded from the Precambrian crystalline highlands of northern New Mexico early in the Laramide orogeny. The conglomerates represent debris-flow, sieve and high-energy, braided-stream gravel deposits. The immature, sand-sized particles were derived from proximal sources in the Brazos uplift during the final stages of the Laramide orogeny. The sandstone units represent sheet-flow sediments deposited from lower energy, braided streams with more easterly sources than the sources for the conglomerates.

Point counts of thin sections of four sandstone samples show high QFL% quartz and QpLvmLsm% metamorphic lithics. These results are consistent with a provenance in the Precambrian metamorphic core of the Brazos uplift. Extensive diagenetic effects typical of Cenozoic desert alluvium include calcite, zeolite, and hematite pore-filling and replacement of grains, alteration of feldspars, and removal of heavy minerals.

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Historical Geology as Framework for Synthesis and Management of Data from Environmental Impact Studies in New Mexico

Development of New Mexico's energy resources and concomitant utilization of other resources produce unavoidable impacts on the environment. Although areas involved in specific projects are comparatively small, the cumulative extent of impacted areas is substantial. Currently, required studies of impacts produce inventories and descriptions of discrete subjects (e.g., climate, water quality, soils, biota, archeology, paleontology, etc) without relating the subjects to a larger system, or more completely analyzing their scientific potential in the context of natural systems. Historical geology provides a framework for a unified study of the dynamics of the predevelopment environment. This synthetic approach indicates which data are redundant and what further data are needed, provides a long-term baseline for evaluating impacts of development, and provides insights for mitigation of adverse impacts. Because historical geology considers the chronology of changing landscapes and their ecology, the environmental context of data is essential for reconstructing the

past. Geologists in research and regulatory organizations should determine which data are needed to describe the geologic history of affected regions to alert developers and impact assessors of potential areas for further investigation. The historical-geology approach to evaluating impacts is beneficial to both energy industries and the public because adequate rehabilitation can only be based on an understanding of the dynamics of the affected system.

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Recognition, Age, and Extent of Galisteo Formation, North-Central New Mexico

Since Hayden's original definition of the Galisteo Formation, there has been some confusion over its upper and lower limits, age, and distribution in New Mexico. A measured section 1,100 m thick of the Galisteo in its type area east of Cerrillos provides a firm basis for recognition of the formation in other areas by enabling lithologic and biostratigraphic correlation of major Galisteo outcrops.

Steeply dipping and locally overturned strata of yellow and brown coarse-grained and pebbly sandstone dominate the lower 353 m of this section and unconformably overlie yellow and white medium to coarse-grained sandstones of the Cretaceous Mesaverde Group. Early Eocene mammals of the Cerrillos local fauna are present in red mudstones 369 to 424 m above the Mesaverde-Galisteo contact. The upper 186 m of the Cerrillos section is dominated by yellow coarse-grained and pebbly sandstones that locally contain numerous fossil logs. Latest Eocene mammals of the Tonque local fauna are present in the upper 231 m of this section. The locally conformable contact between the Galisteo Formation and the overlying Espinaso Volcanics is at a 5-m-thick transition zone of tuffaceous clay and sandstone.

Strata of the upper part of the Galisteo Formation in the Hagan basin and Rio Puerco fault zone contain mammal fossils of the Tonque local fauna and can be lithologically and biostratigraphically correlated with the Cerrillos section. Other isolated Galisteo outcrops lack fossils but can be lithologically correlated, albeit imprecisely, with the Cerrillos section. Parts of the Galisteo Formation are time equivalents of the lower Eocene San Jose Formation and the Eocene part of the Baca Formation, but lithologic and structural evidence demonstrates that the Galisteo Formation is a rock-stratigraphic unit distinct from these two formations.

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Evaluation of Geothermal Potential of Truth or Consequences Area, New Mexico

Truth or Consequences, New Mexico, is the site of a known thermal anomaly with free-flowing artesian wells and springs ranging in temperature from 36.7 to 45.6°C. Recently completed electrical resistivity surveys and hydrogeologic studies indicate two specific areas worthy of further evaluation for low to moderate-temperature geothermal potential: one area about 1 km northwest of Truth or Consequences, and the other at the southwestern end of the Mud Springs Mountains. The DC electrical resistivity study consisted of three Schlumberger vertical electric soundings and an extensive roving bipole-dipole survey in the vicinity of the previously mentioned target areas. Three total-field apparent resistivity maps were generated from the data collected during the roving bipole-dipole survey. To demonstrate the effect of lateral heterogeneities in the geothermal reservoir zone, these maps were compared with theoretical total-field maps computed for a one-dimensional layered earth.

Combined electric, hydrologic, and lithologic data indicate that the major thermal aquifer is a fault-bounded block of Pennsylvanian limestone with a major recharge area in the Mud Springs Mountains. This carbonate aquifer is approximately 1 km thick and, locally buried as much as 120 m beneath Quaternary alluvium and the nonthermal piedmont aquifer. Transport of thermal waters from the carbonate aquifer into the Rio Grande flood-plain aquifer occurs along a N60°W-trending reverse fault zone which dips 60°N. Latest movement along this fault zone has tentatively been dated as middle to late Pleistocene. The heat source for the thermal aquifer may be related to early Pleistocene igneous activity.

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Los Pinos Formation (Oligocene-Miocene), North-Central New Mexico

The Los Pinos Formation, generally considered Miocene in age, has been remapped in the Tusas Mountains of north-central New Mexico. The lower part contains igneous breccias and volcaniclastic facies equivalent in petrology and age to the Oligocene Conejos Formation. The upper part of the Los Pinos is composed of volcaniclastic sediments from three source areas: (1) the San Juan Mountains, (2) the Questa area, and (3) a possible volcanic center southeast of Tres Piedras. This newly determined possible center southeast of Tres Piedras was apparently the source of several rhyolitic ash-flow tuffs. Ash-flow tuffs, including some from the Treasure Mountain Tuff, the Masonic Park Tuff, and two unnamed tuffs, underlie or interfinger with the upper Los Pinos Formation. Clasts of ash-flow tuffs from the source area southeast of Tres Piedras are similar to those in the Abiquiu Tuff.

The Los Pinos Formation and its probable stratigraphic equivalents (Picuris Tuff and Abiquiu Tuff) were deposited from at least Chama to Taos and from the San Juan Mountains to the Jemez Mountains. This pattern of deposition was disrupted by the formation of the Jemez volcanic center, the Rio Grande rift, and the excavation of the San Juan basin.

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Estimates of Gas Content in Coal and Carbonaceous Rocks from Deep Drilling in Pacific Creek Area, Northeastern Green River Basin, Sweetwater County, Wyoming

Coal, carbonaceous shale, and siltstone have been tentatively identified as some of the more important source rocks of gas in low-permeability gas reservoirs in the greater Green River basin of Wyoming and Colorado. An attempt to quantify the amount of gas presently contained in these source rocks was initiated during coring of the Rainbow Resources-Pacific Creek Federal 1-3 well, located north of the Rock Springs uplift in the northeastern Green River basin. The direct gas desorption method developed by the U.S. Bureau of Mines was used. Three samples of carbonaceous shale and siltstone from a depth of 13,450 to 13,500 ft (4,099 to 4,115 m) in the Upper Cretaceous Rock Springs Formation were collected and desorbed. The gas content of these samples ranges from 23.0 to 74.8 cu ft/ton (0.65 to 2.1 cu m/T). The weight percent of