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

total organic carbon ranges from 0.57 to 7.81 and the vitrinite reflectance is 1.2 R_O.

Although no coal was cored, a gas estimate ranging from 1.0 to 1.5 bcf/sq mi (0.07 to 0.11 billion cu m/sq km) was calculated using a graphic solution based on existing coal desorption data from other areas. Coal beds were identified from geophysical logs in the stratigraphic interval from the Tertiary Fort Union Formation through the Upper Cretaceous Mesaverde Group; coal rank was determined from a vitrinite reflectance profile in the Pacific Creek area. The aggregate thickness of coal in this interval is 200 ft (61 m), and the coal rank ranges from high volatile C bituminous to medium volatile bituminous.

The results obtained in this limited study indicate that the direct method of gas desorption works at great depths and provides what appears to be fairly reliable gas estimates. Calculations of the amount of gas contained in coal beds show that a very large volume of gas has been generated.

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Environment Favorable for Deposition of Uranium, Jefferson River Basin, Southwestern Montana

Evaluation of 2° quadrangles for the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) has shown that numerous Tertiary basins in southwestern Montana are potentially favorable for uranium deposits. However, only a few criteria essential for uranium deposition have been substantiated in each favorable basin. These criteria include one or more of the following: demonstrable source rock, evidence that uranium has been leached from the source and transported in surface or ground water, favorable host lithologies, potential reductants, and permeability contrasts. A small area of the Jefferson River basin adjacent to the northern end of the Rader Creek pluton of the Boulder batholith is of particular interest because it meets most of these criteria.

As much as 65% of the uranium has been leached from higher parts of the Rader Creek granodiorite during unroofing. This is indicated by trend surface analysis of modal data and major oxides from the pluton, and by significant correlations between elevation and U_3O_8, Th/U, and other selected geochemical variables within the pluton.

Surface drainage and near-surface ground water within the Rader Creek pluton carry leached uranium eastward into the Jefferson River basin. Streams draining the pluton contain up to 25 ppb uranium, whereas ground water from wells in the Tertiary basin sediments just adjacent to the pluton contains up to 50 ppb uranium. These fluvial and lacustrine Tertiary sediments were derived mainly from the Boulder batholith. Permeability contrasts in these sediments provide suitable sites for uranium concentrations. Traces of carbonaceous material and reduced sulfur-bearing hot springs are indications of adequate reductants for uranium.

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Model for Origin and Distribution of Low-Temperature Geothermal Resources in Rio Grande Rift, Southern Rocky Mountain Complex

Compilations of geologic and geophysical data from the Rio Grande rift indicate numerous geothermal anomalies, a few of which have been confirmed by subsurface temperature measurements. With the exception of anomalies associated with the Jemez Mountains, and possibly those near Socorro, there is no strong evidence to indicate that the anomalies are magmatic in origin. However, there is a strong correlation between the locations where the ground water discharges from one basin to the next, and the confirmed geothermal anomalies. A ground-water flow model, based on slow flow through the deeper basin horizons, explains the magnitude and distribution of the confirmed anomalies. Ground-water flow in the model is driven by the hydraulic gradients in the basins with no closed thermal convection cells. Regionally high heat flow heats the ground water but the anomalies are located where the hot water rises naturally at the constrictions at the southern ends of the basins. The model indicates that intermediate to low temperature geothermal fluids may be encountered by deep (3 km) drilling in the basins, although low permeabilities at these depths may restrict production of fluids. It is more economically attractive to tap the flow systems where the hot water rises naturally at the basin constrictions. Data from two 300-m wells in the Las Alturas geothermal anomaly in south-central New Mexico are consistent with the ground-water flow model and indicate that near maximum temperatures may be reached at relatively shallow depths and deeper drilling may not encounter significantly higher temperatures.

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Petrology of Pennsylvanian Tensleep Sandstone, Lost Soldier Field, Wyoming

The Pennsylvanian Tensleep Sandstone in the Lost Soldier field of Sweetwater County, Wyoming, is composed of texturally homogeneous, fine-grained sandstones and interbedded dolomite beds. Geologic setting and sedimentary features indicate that the Tensleep was deposited in supratidal-eolian environments. Detailed, petrographic, cathodoluminescence, and SEM analyses of core samples show nine diagenetic events in the Tensleep: (1) early calcium sulfate cementation; (2) precipitation of feldspar overgrowths; (3) poikilotopic nodular calcite cementation; (4) nodular anhydrite cementation; (5) late anhydrite cementation; (6) precipitation of silica overgrowths and silicification of carbonates; (7) alteration of feldspar; (8) dolomite cementation and dolomitization; and (9) hydrocarbon migration and accumulation. Four diagenetic facies with specific patterns of alterations have been identified: (1) early carbonate-precipitation facies; (2) early anhydrite-cementation facies; (3) primary carbonate-grain facies; and (4) nodular-cementation facies. Diagenetic alterations in each diagenetic facies were primarily controlled by lithologic characteristics within the original depositional environments. The carbonate-rich diagenetic facies are closely associated with the supratidal sabkha depositional facies. The anhydrite-rich facies is related to the interdune sabkha depositional facies, and the nodular-cementation facies is present within rocks deposited in the eolian-dune facies.

Reservoir qualities (porosity and permeability) of the Tensleep Sandstone in the Lost Soldier field vary considerably and, with the mineral composition of the Tensleep, were modified significantly by diagenetic alterations. They can be estimated from knowledge about the distributions and associations of depositional and diagenetic facies.