gas reserves for this section are calculated at 252 billion cu ft/sq mi.

Extensive logging, coring, and testing have been carried out in the program, including special logs for rock mechanics study. Cores were compared with those from Gasbuggy as to compressive strength, shear behavior, and potential for fracturing. Petrographic analyses indicate better fracture potential at Wagon Wheel due to a higher degree of grain to grain contacts and lower clay content.

Environmental protection studies include examination of surface waters, springs and wells, man-made structures, mines, flora, fauna, and general land use. The most important aspect from a geologic standpoint is protection of the extensive groundwater aquifers above the gas reservoir. Two wells, in addition to the Wagon Wheel No. 1, were drilled for the purpose of evaluating those aquifers. Potable water extends to a depth of approximately 3,600 ft. Salt water occurs from 3,600 to approximately 5,200 ft. Low quality subpotable water extends from 5,200 to about 7,200 ft. The saltwater zone is interpreted to be in a tongue of Wasatch Formation extending from the west into Eocene arkoses derived from the Wind River Range on the east.

Plans call for sequential detonation of 5 explosives spaced at intervals from 9,220 to 11,560 ft to produce a more or less continuous chimney from about 8,700 to about 11,600 ft. There will be a safety margin of 1,500 ft between the top of fractures and the bottom of known aquifers.

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Phosphate Deposition Seaward of Barrier Islands at Edge of Phosphoria Sea in Northwestern Wyoming

Four elongate tongues of the Shedhorn Sandstone of Permian age extend southeastward from the Yellowstone Park area into the Gros Ventre, Hoback, and Wyoming Range area. These tongues represent barrier-island complexes that built southwestward in the Phosphoria sea, creating a lagoon on their northeast side. The lagoonal facies includes algal laminated and ostracodal limestone and dolomite and a greenish-gray shale. The barrier island facies consists of crossbedded quartz sandstone which contains abraded thick-shelled fossils. The marine facies southwest of the barrier island facies includes chert, quartz sandstone, calcarenite containing a siliceous sponge, brachiopod, and bryozoan fauna, and phosphorite containing a brachiopod and fish fauna. Major phosphate deposition was restricted to the marine environment seaward of the barrier islands, and was absent in the lagoonal environment.

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Bedded Zeolites in United States—Potential Industrial Minerals

Zeolites are among the most common authigenic silicate minerals in sedimentary deposits. Zeolites occur in rocks that are diverse in age, lithology, and depositional environment, but they are most common in sedimentary rocks that originally contained abundant vitric material. Of the more than 30 naturally occurring zeolites, 6 commonly occur in bedded deposits that have not been subjected to deep burial or hydrothermal activity. These are analcime, chabazite, clinoptilolite, erionite, mordenite, and phillipsite. They are generally more siliceous and more alkalic than their counterparts that occur in mafic volcanic rocks. Most zeolites in sedimentary rocks formed during diagenesis mainly by reaction of vitric material with interstitial water, which may have originated as either meteoric water or connate water of a saline, alkaline lake. Formation of zeolites is favored by a relatively high pH and high activities of alkali ions in the interstitial water. Most zeolitic sedimentary rocks consist of 2 or more zeolites with authigenic clay minerals, silica minerals, or feldspars, and relict glass and crystal and rock fragments. Extensive and relatively pure beds of zeolite, however, occur in upper Cenozoic lacustrine deposits of the western United States.

The ion exchange, adsorption, and molecular sieve properties of zeolites, coupled with a seemingly low cost of mining, suggest a variety of industrial applications. Potential uses include purification and drying of gases and liquids, chemical separations, catalysis, decontamination of radioactive wastes, removal of ammonia from wastewater, and numerous other uses in agriculture and animal husbandry. Potential uses of these zeolites could be considerably increased by chemical and structural modifications of the natural materials.

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Marine Diagenesis of Carbonate Sediment, Bonaire, Netherlands Antilles

A discontinuous layer of lithified carbonate sandstone underlies a small part of the Lac, a large lagoon on the southeastern coast of Bonaire. The layer lies 35 cm below the sediment surface, varies from 5 to 20 cm in thickness, and is restricted to an area beneath a broad intertidal and subtidal flat. Beachrock crops out in the high intertidal zone.

The lithified layer consists of grainstone cemented by acicular aragonite. Numerous lines of evidence indicate the cementation occurred in the marine environment. The lithified layer is at present continuously saturated with normal seawater. The submarine-cemented rocks lack the gray algal coating which is characteristic of beachrock and subaerially exposed coral rubble. Carbon-14-dating of the rock indicates cementation occurred less than 900 years ago. Study of the constituent particles of the lithified layer and the sediment above and below indicates continuous marine sedimentation.

Several distinct types of micrite are present in the beachrock and submarine-cemented layer. The most common is a high- and low-Mg calcite which coats single and multiple skeletal fragments with a sharp contact between the grain and micrite. The coating results from micritization of the high-Mg calcite of the encrusting coralline algae. Electron microprobe and X-ray diffraction analysis of these coatings demonstrated that as micritization proceeds and the microstructure of the algal coating is destroyed, the mineralogy changes from high- to low-Mg calcite.

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Oil Boom in Indonesia—Too Optimistic?

Since the awarding of Indonesia's first offshore-production sharing contract to IIAPCO in August 1966 the boom has been on. Never before have so many different contractors searched so intensely for oil anywhere in southeast Asia. More miles of geophysical work have been done in the past 5 years than in all previous periods of Indonesian exploration. Even though oil drilling activity in Indonesia began in 1872, more widely scattered exploratory tests have been drilled in the current exploration cycle than during any comparable exploration period. The results have been variable. Although most exploration data remain confidential, it is known that some geologic interpretation and dogma have been disproved. Even though the majority of the exploratory ventures have resulted in economic failure, a measure of success has been recorded in 3 areas. The Ardjuna and Cinta fields are producing at the rate of 25,000 and 40,000 bbl/day of oil, respectively, and the Ardjuna complex is expected to reach 75,000 bbl/day of oil in late 1972. Also, the Attaka field was scheduled at 30,000 bbl/day of oil by October 1971 and to exceed 100,000 bbl/day of oil during 1973. These do not appear to be giant oil fields, but they are economic ventures. The Attaka field, containing an estimated 300 million bbl of recoverable oil, appears to be Indonesia's best offshore discovery to date.

Will another giant oil field like Minas be found? The applicable geologic criteria do not rule out the possibility, but the probability of several small giant fields being present appears better. The current search, with a fair measure of success, should discover them.

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NEAR-SURFACE COAL RESOURCES AND RESERVES OF WESTERN UNITED STATES

Near-surface resources of coal and lignite in 11 of the 14 western states of the conterminous United States are estimated by the Bureau of Mines to be 48 billion tons; of this amount 26.7 billion tons could be economically recovered under present economic conditions by strip mining.

About 24.8 billion tons of this strippable reserve is low-sulfur coal (below 1% sulfur), 1.5 billion tons is medium-sulfur coal (1–2% sulfur), and 0.5 billion tons is high-sulfur coal (over 2% sulfur).

The Bureau has estimated the near-surface resources of coal and lignite in the United States to be 119 billion tons. About 45 billion tons of this resource is economically recoverable by strip mining. About 32 billion tons of this is low-sulfur coal, 4 billion tons is medium-sulfur coal, and 9 billion tons is high-sulfur coal.

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DEPOSITIONAL CYCLES OF LODGEPOLE FORMATION (MISSISSIPPIAN) IN CENTRAL MONTANA

Detailed stratigraphic and petrographic investigations of lower Madison Group outcrops reveal that the Lodgepole Formation is composed of 5 two-part depositional cycles. The stratigraphically lowest cycle includes the entire Paine Member; the remaining cycles comprise all but the lower part of the Woodhurst Member.

Each cycle is characterized by a fine-grained lower unit and a coarser upper unit. The lower unit is dominated by horizontally laminated carbonate mudstones, pellet carbonate grainstones, and finely crystalline dolomites. These lithologies are interpreted to be the deposits of calm, nonturbulent lithotopes. The upper unit of each cycle is characterized by cross-laminated, medium- to coarse-grained, bioclastic and oolitic carbonate grainstones, interpreted to have been deposited in shallow, turbulent environments. From the lithology, sedimentary structures, lateral petrographic and stratigraphic continuity, and modern analogues, these oolitic and bioclastic beds are interpreted to be generally synchronous within individual outcrop belts in central Montana. Regionally, however, cycle-capping intervals are probably diachronous stratigraphic units.

Facies interpretations of Lodgepole depositional cycles suggest that rocks of the fine-grained lower unit are deposits of deeper water transgressive phases of the Lodgepole sea; lithologies of the upper coarse-grained unit are accumulations of the shallower water regressive phases.

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REEF CALCIFICATION

Of the life processes on a coral reef, calcification produces the most conspicuous end product—the reef framework and sediments. Most of the information relevant to coral-reef calcification comes from studies of the rates of $CaCO_3$ retention by the reef or studies of individual organism calcification rates. Neither of these types of studies really assesses the rate at which the reef community produces $CaCO_3$.

Alkalinity depletion as water flows across a reef, together with volume transport of that water, can be used to compute the rate of reef calcification. This procedure has been employed across a predominantly coral community and across a predominantly coralline algal community on windward inter-island reef flats of Eniwetok Atoll, Marshall Islands.

The mean alkalinity of water approaching the reef is about 2.30 meq/l, and the alkalinity as the water crosses the reef is typically depleted by less than 0.01 meq/l. The product of Δ alkalinity times volume transport, divided by the reef length, averages approximately 0.0025 (meq/sq m)/sec, with no significant difference in depletion rate between the 2 calcifying communities examined. This alkalinity depletion rate is equivalent to a $CaCO_3$ production rate of 4×10^3 (g $CaCO_3/m^2$)/year.

If the porosity of the sediment produced by calcification is 50%, then the $CaCO_3$ production rate is sufficient for an upward reef growth rate of about 3 mm/year. Because the present rate of eustatic sea level rise is considerably less than 3 mm/year, the reef is either catching up with sea level, or most of the $CaCO_3$ produced is being removed. Sediment accumulations downstream from actively calcifying reef areas favor the latter hypothesis.

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SEQUENCE OF BEDFORM AND STRATIFICATION IN SILTS, BASED ON FLUME EXPERIMENTS

Flume experiments with 2 silt sediments indicate development of a sequence of bed forms and stratification which is systematically related to flow intensity. At a fixed flow depth, each silt is transported as ripples over a wide range of mean velocities above the threshold for movement. With still higher velocities, ripples disappear abruptly and a flat-bed mode of transport occurs. Dunes are not present at velocities intermediate between rippled and flat beds, as they are for sand.

At lower velocities, ripples develop forms very similar to sand ripples: planar lee slopes accrete by slump-