... sweep the bases of continental slopes. Similarly, "bottom" currents which are moving at slower velocities deeper on the continental rises will form varied longitudinal profiles characteristic of particular bottom conditions. Redistributed terrigenous materials which in large part compose these anticlines are carried into current systems by intermittent gravity sliding and turbidity currents.

A striking example of wind-driven current deposition occurs in the Florida Strait where calcareous sands from the Florida reef vicinity are swept along a trough by the Gulf Stream, then onto a broad anticlinal rise. Examples typifying "bottom" current anticlines are numerous in the North Atlantic, and deep-water coring programs have partly revealed their sedimentary sequences.

A wind-driven current origin can plausibly explain the Poza Rica trend in Mexico. As the Golden Lane had contributed its Tamabra talus downslope into shelf currents of the Chicontepec foredeep, anticlines were shaped at the base of the slope. Similar origins are suggested for other examples in the geologic record.

Significant reserves in anticlines formed by current deposition will be found beyond the reefs and laterally away from the deltas in the deep environment where the subtle character of these features must come to be recognized. Reservoirs such as Poza Rica attest to the excellent rock properties and trap conditions which can be realized in an inspired search for such targets.

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WORLD'S ENERGY ECONOMY

The earth is a virtually closed material system composed of the 92 naturally occurring chemical elements, all but a minute radioactive fraction of which obey the laws of classical chemistry. Into and out of this system there occur a continuous flux and degradation of energy. As a consequence, the materials of the earth's surface undergo either continuous or intermittent circulation. The principal energy influxes into the earth's surface environment are three: solar energy 174,000 trillion thermal watts; geothermal energy, 32 trillion; and tidal energy 3 trillion. The outfluxes are low-temperature radiation into outer space.

During more than 3 billion years of geologic history, a minute fraction of the materials of the earth's surface has been aggregated into the dynamical system of living organisms. By the process of photosynthesis, a small fraction of the incident solar radiation is captured by the green leaves of plants and is stored chemically in the organic molecules of carbohydrates and other more complex chemical compounds. This is the source of the physiological energy requirements for the entire plant and animal kingdoms. The rates of decay and of oxidation of organic materials are almost equal to their rate of formation, but a small fraction becomes buried in peat bogs or other oxygen-deficient environments of incomplete decay. Such accumulations during past geologic time have become buried under thick accumulations of sedimentary strata and have become transformed into the earth's present supply of fossil fuels.

By about 2 million years ago the ancestors of the present human species began to walk upright and to use stone tools. From that time to the present, this species has distinguished itself from all others in its cumulative inventiveness in means of capturing ever-larger quantities of the energy of its environment. A great increase in the consumption of energy per capita was not possible, however, until the exploitation of the large stores of energy of the fossil fuels was begun about 9 centuries ago. The rise of the world's present technological society, with its concurrent ecological disturbances, including that of the human species, has been an inexorable consequence.

The length of time during which this has occurred is deceptive unless account is also taken of the exponential growth in the rates of consumption. During the 9 centuries since the beginning of coal mining, approximately 142 billion metric tons had been mined by the end of 1972. Of this, one half has been produced since about 1940. Eighty percent of the world's initial coal supply will be consumed within the next 2–3 centuries, and the middle 80 percent of the world's oil during the 65-year period from about 1967 to 2032.

As to the future, the fossil fuels are short-lived; nuclear power is potentially large but also hazardous; water power is large but inadequate; and geothermal and tidal power are inadequate. On the other hand, the largest source of energy available to the earth is that of solar radiation. Because the earth itself cannot tolerate more than a few tens of doublings of any biological or technological activity—and most of these have occurred already—it is now becoming evident that the present episode of exponential industrial growth can be only a transitory epoch of about 3 centuries duration in the totality of human history. It represents a brief transitional period between two very much longer periods, each characterized by rates of change so slow as to be regarded essentially as a period of nongrowth. Although the forthcoming period poses no insuperable physical or biological difficulties, it can hardly fail to force a major revision in those aspects of our current economic and social thinking which are based on the premise that the growth rates which have characterized this temporary period can somehow be sustained indefinitely.

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MARS GEOLOGIC HISTORY AND PROCESSES

The year-long observations of Mars by Mariner 9, combined with earlier spacecraft and ground-based data, have demonstrated a complex evolution for the Martian crust and a complex interaction between crustal and surficial processes that is still in progress. Volcanic, tectonic, and impact processes are prominent in the development of the crust; eolian, glacial, fluvial, and mass-wasting processes are paramount in surface modification.

Maps of Mars prepared from television pictures can be correlated with the planetary shape from occultation data, pressure elevation mapping, ground-based radar, and gravity measurements. The southern hemisphere and equatorial zone are underlain by high standing "continental" rocks; the northern region by low-lying "oceanic" basins underlain by basaltic rocks.

Based on these data, a history of the crust of Mars can be developed. The major events are (1) early differentiation of the crust and segregation into highlands and lowlands; (2) impact cratering; and (3) continued volcanic activity in the highlands and lowlands involving emplacement of basaltic and silicic rocks. Concurrent or later modification includes (1) formation of chaotic terrain by slumping; (2) formation of three types of fluvial channels in the equatorial belt; (3) formation of glacio-eolian deposits in the polar regions; and (4) regional eolian erosion and deposition.