

W. Decker of Dartmouth College told the Science and Man in the Americas meeting in Mexico City. Decker emphasizes the word "forecasting" as in probabilistic weather forecasting—rather than prediction—"to convey this same sense of useful though uncertain predictions of events which lie in the future."

"No single predictive index appears to be the master key to volcano forecasting," Decker notes. Volcanologists try to combine evidence from past history, geology, seismicity, surface deformation, magnetic and electric phenomena, and geochemistry. With the present state of the art, he says, strict zoning can probably save more lives than prediction.

"However, the situation is not hopeless." Useful though not precise forecasting is currently being practiced at Asama in Japan, at Taal in the Philippines, at Besymianny in Kamchatka, at Kilauea in Hawaii and at a few other volcanoes under continuous observation. "The only master key is better understanding of volcanic processes."

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A paper relating volcano eruptions and earth tides, reported in SCIENCE NEWS last October (10/21/72, p. 261), is published this week in the JOURNAL OF GEOPHYSICAL RESEARCH, along with another paper reporting similar findings by Wayne L. Hamilton of Ohio State University. Hamilton has found that the frequency, intensity and latitude of occurrence of volcanic eruptions vary

systematically within the well-known tide cycles. Eruptions are favored in months in which earth tides are large at the latitude of the volcano. He found that the eruptions of two volcanoes, Pelee and Soufriere, occur when two types of wave forms from the tides nearly synchronized.

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Several volcanologists are pointing

Desert shrubs called 'the neglected resource'

Their names carry the flavor of the Western desert country: sagebrush, salt-bush, creosote bush, burro sage, mesquite, cholla. Hardy, tough, enduring, these and other shrubs of the arid lands survive difficult conditions through superior adaptability.

Shrubs are the dominant vegetation of arid and semiarid regions, but they are among the most misunderstood, most neglected and least used plant forms in the world. So says Cyrus M. McKell, professor of range science and director of the environment and man program at Utah State University. They are, says McKell, a hidden resource.

Desert shrubs need someone to champion their cause, and McKell has taken on that task. In a paper delivered at the Science and Man in the Americas meeting in Mexico City, he lists six popular misconceptions about shrubs:

- Shrubs are worthless invaders. Shrubs that appear worthless to persons unfamiliar with a region may frequently be useful for grazing and other purposes, he says. "The worth of a so-

to signs of a potentially dangerous major eruption of San Cristobal volcano in Nicaragua. Large-volume, high-temperature fumarolic activity in the crater began in May 1971 after 300 years of dormancy. Studies by Richard Stoiber of Dartmouth show an increase in the ratio of sulfates to chlorine in the volcanic gases, a probable indication of a new eruptive period. □

called invader shrubs can only be determined by an overview of its total ecosystem relationships." Sometimes shrubs make farming possible in areas where nomadism would otherwise be the only agricultural activity.

- Shrubs are generally unpalatable to all livestock except goats. "In reality, a significant proportion of the herbage removed by grazing animals comes from shrubs. . . . Not only is the herbage from shrubs palatable to most animals but it may also be crucial to achieving a balance in the nutrient intake"

- Large areas of valuable land are occupied by worthless shrubs. This involves relative values, McKell points out. "Existing 'worthless' shrubs might have useful properties that are simply unknown or undeveloped." He mentions the liquid wax from the jojoba (see p. 26), high-protein fodder from *Atriplex*, latex from the guayule, and other species high in fatty acids, protein, essential oils. "Some of these could be very useful as 'crops' for arid lands. Under such conditions, many 'worthless' shrubs would have to be reevaluated!"

- Shrubs are low in feed value. "Shrubs are high in digestible protein, phosphorus and carotene."

- Shrubs are spiny and harsh and are therefore a menace. "Not all shrubs are harsh and spiny." Some species "may look formidable, but the net effect is generally not a deterrent to their use."

- Shrub eradication is an essential and an important step in any range improvement program. This is "the most serious and erroneous misconception." At times complete control of shrubs has been a goal of range management. "To manage arid lands wisely requires that we work positively regarding the various advantages of individual shrub species rather than use a shotgun approach designed at indiscriminate control of shrubs per se."

What are the ways arid-land shrubs are useful to man? McKell is not at a loss for answers. They can be used for livestock and animal feed ("existing use of shrubs for domestic animal feed falls far short of the possible potential"). They can lead to commercial products ("many opportunities"). They

Are the continents propelled by elastic energy?

A major objection to the geophysical theory of plate tectonics or continental drift, to use its older name, is that there doesn't seem to be a sufficient source of energy in the outer layers of the earth to move such heavy things around.

A possible answer to that objection is provided in the June 25 NATURE PHYSICAL SCIENCE by David Pines and Jacob Shaham of the University of Illinois at Champaign-Urbana. They propose that elastic energy stored in the crust and mantle of the earth is sufficient for the purpose.

The elastic energy is generated by stresses set up as a result of deformations caused by forces acting on the earth. Pines and Shaham figure the stored energy to be about 10^{32} ergs at present. They figure that continental drift and seismic activity each release about 10^{25} ergs per year, or about one ten-millionth of the present reserve.

Pines and Shaham propose a theory whereby such motions as continental drift, earthquakes and polar wandering tend always to reduce the energy stored in this elastic "reservoir." This, they say, explains the westerly direction of polar wandering and the drift of continents toward the equator, both of which are observed.

Pines and Shaham propose an "elastic epoch" dating from a cataclysmic event or series of events a hundred million to a billion years ago. They figure this is the best way to get the distortion and the energy storage since it is difficult to see how it could happen otherwise on an earth that is gradually spinning down. They surmise that such a cataclysm might have been the capture of the moon. They suggest then that scenarios could be devised starting from a particular lithospheric configuration at that time, say a supercontinent, and coming down to the present by energy-dissipating motions.