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MINERAL INFORMATION SERVICE

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MINERAL INFORMATION SERVICE is designed to report on the progress of earth science in California, and to inform the public of discoveries in geology and allied earth sciences of interest and concern to their lives and livelihood. It also serves as a news release on mineral discoveries, mining operations, statistics of the minerals industry, and new publications. It is issued monthly by the California Division of Mines and Geology. Subscription price, January through December, is $1.00.

Other publications of the Division include the Annual Report of the State Geologist; the Bulletin, Special Report, Map Sheet, and County Report series; the Geologic Map of California; and other maps and publications. A list of the Division's available publications will be sent upon request. Communications to the Division of Mines and Geology, including orders for publications, should be addressed to the San Francisco office.

MARY R. HILL, *Editor*

A LETTER TO THE EDITOR

Dear Madam:

Reading the August Mineral Information Service reminds me of one of my pet ideas: that all licensed surveyors should be required by law to file maps of lands or plots surveyed professionally.

Such action would create a record of widespread surveys that would on occasion come in handy for reference by state or geodetic surveyors in addition to creating a basis for other surveys in the same area.

I had a section surveyed in the desert in 1950 and had it recorded. It was the first recorded survey of the spot since about 1835. Since 1950 probably two dozen surveys have been run in and around the area, and my record was undoubtedly used as a base. I feel that by having the record made I helped a lot of people, and it cost me only a couple of dollars. The ONLY recorded survey since 1950 has just been completed by the county.

Would it not be to the advantage of all surveyors of all classes if all surveys were recorded? The selfishness of private surveyors in keeping their records to themselves appears to me to be unjustified.

Yours,

Ross H. Porter

NEW "PRIMER" ON WATER QUALITY

The subject of water quality—what it means, how it relates to a number of water problems—is covered in a new "primer" published by the U. S. Geological Survey. The primer can be purchased for 30 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The 27-page publication, titled "A Primer on Water Quality", is written in nontechnical language by H. A. Swenson and H. L. Baldwin, and is the third in a "primer" series designed to explain basic concepts of water, and to clarify water facts and problems. Previously published in the series are: "Primer on Water", and "Primer on Ground Water." All include simplified descriptive diagrams and tables.

"Never before in our Nation's history," said Dr. Luna B. Leopold, Chief of the Survey's Water Resources Division, "has there been such a need for a better understanding of the basic principles of hydrology—the science of water—and problems relating to water sources, supplies, use, and management. The primers are aimed at providing this basic understanding for a nontechnical reader, as well as for the student and teacher of the earth sciences."

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The author of the following article is a visitor to the United States, on leave of absence from the University of London. He has spent the past year at the University of California at Los Angeles, from which base he has been studying the Mojave Desert of California under the sponsorship of the American Council of Learned Societies. Professor Cooke is no stranger to deserts; he has spent three field seasons in the Atacama Desert of northern Chile. We welcome him to the pages of Mineral Information Service. . . . *Edit.*

Desert surfaces are of immediate concern to all who explore arid lands, for their nature determines the ease with which they can be crossed. We are keenly alert when driving through areas of loose sand and we are prepared for trouble on the deceptively firm flats of the moist floors of dry lakes. Rocky terrain demands a sturdy vehicle or careful footwork. What a relief it can be to encounter "desert pavement"—broad stretches paved with an intricate mosaic of coarse angular fragments set in a firm matrix of fine sand! The stony armor prevents vehicle tires from biting into the dust and grinding their way into the ground. Desert pavement has another function too: it protects the material beneath from the natural forces of erosion which are working incessantly on the skin of the earth.

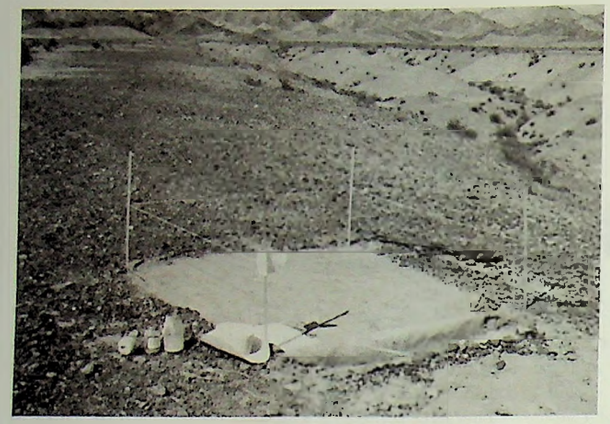
Here naturally armored surfaces are called desert pavements. In north Africa and the Middle East they are "hamadas" or "serirs"; in Australia they are "gibbers." They have other names in other places.

A close look at desert pavements in several localities will reveal that their complexity at each site is matched by their immense variety from place to place. The armor is always derived from the underlying material which may be either bedrock, or superficial debris carried some distance from its source. The best pavements—and some might say the only true pavements—are those consisting of angular or rounded particles set in sand. The surfaces of broad spreads of alluvial material, sloping gently away from mountain fronts and cut by drainage channels that prevent flooding, commonly display excellent pavements. There are some fine examples on the eastern flanks of the Panamints in Death Valley; within Panamint Valley; on the alluvial aprons of the Big Maria Mountains north of Blythe; and near Highway 95 west of the Sacramento Mountains.

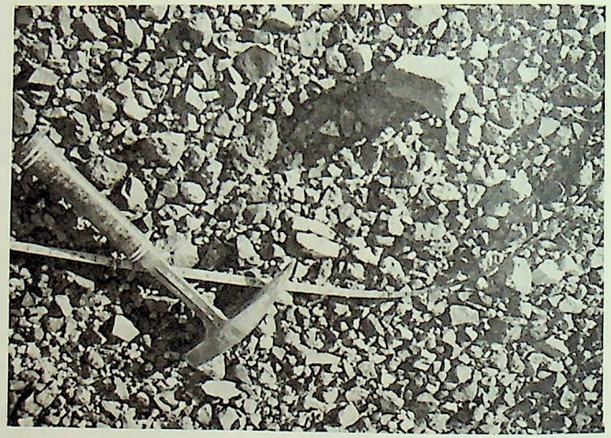
Pavement particles are of widely different shapes, sizes and rock types. Most are angular, but some may be rounded. The gaps between pieces of rock are very irregular. Some fragments lie on the surface while others are embedded in it. Dig a small trench and it may be found that the armor consists of a single layer of particles underlain by a bed of sand, which may be difficult to excavate as it is often cemented by salts. Elsewhere, a vesicular, leached soil horizon, free of pebbles, may underlie the pavement. In other places, the surface may be underlain by a mixture of sand and rock chips; these chips are commonly larger than those in the pavement.

Many rock fragments in the desert pavements of California are coated on their upper surfaces with a thin glossy black film, and on their lower surfaces with a dull brown film. Both films are manganese and iron oxides. This is "desert varnish," and fully justifies a close examination in its own right.

How was the desert pavement formed? William Blake, one of the earliest explorers of Californian geology, gave an answer in 1858. He said "the fact that all the fine sand or dust is removed from between the pebbles near the surface, while it is abundant a few inches below, indicates that winds have gradually blown it away, leaving the heavy pebbles behind. They thus protect the land that lies below them. Indeed, the protective power of this surface of pebbles is worthy of remark; for, if they were removed, it could not be long before the thick, underlying strata of sand would be blown away by the impetuous winds



An experiment to study desert pavement on an alluvial fan.

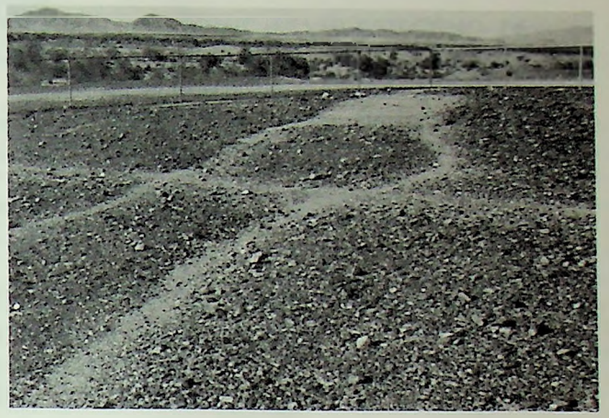


The desert pavement. Notice wide variety of shapes and sizes of fragments. Tip of hammer points to a fragment which has been split at the surface.

of that region." Those who have driven in the desert when a dust storm has been in full swing would agree that the wind can remove a great quantity of fine material from the ground. Occasionally, too, fragments that have been polished or grooved by sand blasting in high winds may be found: some pavements were certainly produced in the way that Blake envisaged. Indeed, his explanation has been accepted by most later desert travellers.

Evacuation of dust by the wind, however, is not the only cause of desert armor. Some pavement areas are sheltered from winds strong enough to remove the sand; elsewhere there may have been little sand to be blown away. Furthermore, fine material is often found on the surface in association with coarse particles of the pavement. For example, frequently dust has been "puddled" into mud by water, and when the mud has dried, a thin skin protects the underlying material from easy removal. In order to remove the dust, the wind must puncture and strip the skin before it can devour the remaining morsels. To do that, it must be charged with particles capable of wearing away the skin. Indeed, in some places, there is, instead of a removal of pavement dust, a local accumulation of wind-blown sand.

We must seek other explanations for the origin of desert pavement. Sometimes, several fragments of a single rock type found close together on the surface can be united into a single "perfect fit," clearly remnants of a single boulder broken up at ground level. Such superficial disintegration differs according to the rock types involved. Granite and other coarsely



Armored surface at the north end of Silver Lake north of Baker, San Bernardino County. The large boulder has been grooved and faceted by wind abrasion.

Indian drawings etched in desert pavement on the terraces of the Colorado River north of Blythe. A poor pavement of small fragments has been developed over them.

crystalline rocks tend to crumble into small irregular particles. Fine-grained rocks, on the other hand, frequently split into a few discrete pieces which can easily be seen to fit together. We are not sure how the breakdown is caused, but rapid changes of temperature, the activity of salts and solutions, changes in humidity, and running water may all help. Running water, furthermore, is probably important in sorting chips and in helping to establish the mosaic pattern.

In areas where the desert pavement overlies a desert soil, a further process may be at work. In these places, the pavement commonly overlies a vesicular, gray-brown A-horizon that contains few particles larger than sand. The stone-free zone beneath the pavement prompts the suggestion that particles may have risen to the surface through the upper layers of the soil. Simple experiments in the laboratory with alternate wetting and drying of reconstituted desert soils indicate that this upward movement of coarse fragments does take place. The causes of this upward migration are not yet clear, but as M. E. Springer suggests, it may be that when a soil is moistened, it expands and lifts the stones slightly. Then, as it dries, it contracts, and produces cavities. If the stones are larger than the cavities they bridge them, and remain at a higher position in the profile. Successive wettings and dryings may eventually raise particles to the surface in this fashion; the same processes may also be responsible for the vesicular structure of the A-horizon.

In summary, most desert pavements consist of primary and secondary particles. Primary particles were originally on the surface, or migrated there from the

underlying soil, were left there after finer material was deflated, or were deposited there by wind or water. Secondary particles are those produced by the disintegration of primary particles at the surface. Winds, so often held responsible for pavement formation, are by no means essential for the establishment of a surface armor; indeed, many of the pavements in the Californian deserts owe little or nothing to wind activity.

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UNITED STATES LAKES TO BE TARGETS OF SPECIAL STUDIES BY GEOLOGICAL SURVEY

Studies of natural and manmade lakes have been expanded significantly since July 1, according to Luna B. Leopold, Chief Hydrologist of the U.S. Geological Survey.

In announcing the Survey's improved program of comprehensive lake studies, Dr. Leopold pointed out that "large lakes on the North American continent contain nearly a fourth of all the fresh surface water in the world, and that thousands of smaller lakes, widely distributed on the continent, which contain less spectacular amounts of water, are highly important locally and regionally."

"Although considerable data have been amassed on our lakes to date," said Leopold, "these data do not explain adequately the nature and behavior of such fresh-water bodies nor indicate their true importance in the larger continental water resources picture."

The hydrologist said that initially, the Survey will concentrate activity on relatively few of the hundreds of thousands of lakes in the 50 States. Modern scientific methods will be used in the study of the Great Lakes and carefully selected smaller lakes.

"For example," Leopold said, "modern remote-sensing techniques will be applied for repetitive collection of data which can be used to describe current situations in the lakes and to chart the changes that occur with the passage of time."

The Survey spokesman explained that some sophisticated remote sensing devices can be used to determine heat patterns in water, the movement and dispersion of sediments, water circulation patterns, and other properties.

Leopold pointed out that "lakes have many important aspects in addition to water supplies. They are important for waste assimilation, shipping, commercial and sports fisheries operations, hydropower generation, recreation, and purely recreational purposes. They inevitably must be tied in with comprehensive plans for water management on continental and regional scales."

Leopold added that it is doubly important to learn more about our lake resources because "many processes that destroy the usefulness of lakes can be accelerated by human activity. These processes go far beyond the problems of pollution in the conventional sense."

The water scientist emphasized that many large lakes, such as the Great Lakes of North America, transcend national boundaries, and their study requires international cooperation.

About 80 nations already have joined the International Hydrological Decade, sponsored by UNESCO, and more are expected. The opening year of the IHD, 1965, coincides with the United Nations International Cooperation Year (ICY), in which President Johnson has pledged vigorous participation by United States agencies.

- Although water demand is increasing, there is no overall shortage of water in the United States. The U.S. Geological Survey has estimated the average total fresh-water supply of our Nation as 1,200 billion gallons a day—twice the projected needs for 1980. There is as much water now in the United States as there ever was, but the geographical distribution of water resources is not always convenient. Los Angeles, for example, obtains its water not only from local sources, but also from the Owens River, 240 miles away on the east side of the Sierra Nevada; from fresh water tributaries to Mono Lake, 350 miles distant, and from the Colorado River, 450 miles east. Present plans call for tapping rivers in northern California to supplement present supplies.

SOUTHWESTERN STATES MAY FIND NEW SOURCE OF WATER IN 'GROUND COATING' TECHNIQUE

Experiments made by hydrologists during the past year at White Sands, New Mexico, have demonstrated the feasibility of "water-proofing" plots of ground with an asphaltic spray, permitting the collection of substantial quantities of rainwater that otherwise would just wet the soil and evaporate uselessly, the U. S. Geological Survey reported today.

The water collected from the sprayed plots can be used directly for supply or recharged to the ground through pits to raise the water table.

Survey hydrologists, cooperating with the U. S. Army at White Sands Missile Range and ESSO Research and Engineering Co., selected two adjacent 9-acre plots at the New Mexico site. One was cleared of vegetation and sprayed with the asphaltic material. The other was left in its natural state. Both plots were equipped with automatic recording devices to measure rainfall and runoff.

On the asphalt-coated plot more than 60 percent of the rainwater was collected in a pit, where it infiltrated to the water table and replenished the groundwater supply. The untreated plot, on the other hand, lost most of its rainwater through evaporation and transpiration by sparse grass and low-value desert vegetation, and only 3 percent of the water was collected. The area has an annual precipitation rate of about 8 inches. With a collection efficiency of 60 percent 130,000 gallons of water would be collected from each acre each year.

Similarly, an area 6 by 9 miles treated with the asphaltic material and having an annual rainfall of 15 inches would collect more than 8 billion gallons of water per year. This amount of water would meet the requirements of a city of 100,000. Treated areas would presumably be selected on the basis of having little or no practical use for agricultural or other development. The water thus obtained, however, must be within convenient reach of a consumer.

Preparation of the area prior to the application of the asphalt will account for much of the cost. However, once the area is prepared, say the hydrologists, the life of the project could be extended by recoating the area periodically.

Geological Survey hydrologists, who have long been involved in the study of water resources in the semiarid Southwest, believe this water "harvest" technique offers promise of a partial solution of some local water deficiencies.

ATOMIC SILVER-DETECTING DEVICE BEING FIELD-TESTED BY GEOLOGICAL SURVEY

An atomic device used in the laboratory for determining small amounts of a wide range of chemical elements is now being tested in the field as a tool for detecting silver by scientists of the U. S. Geological Survey.

In a project sponsored in part by the Atomic Energy Commission, Geological Survey specialists are conducting preliminary field trials to find out whether the new device, dubbed the "Silver Snooper" by its designers, physicists F. E. Senftle, A. F. Hoyte, and P. Martinez, can help in the search to bolster the nation's short supply of silver.

"First field tests are extremely encouraging", reported Drs. Senftle and Hoyte, who are conducting the tests.

The silver-prospecting tests are being carried out at the Department of Agriculture's Research Center at Beltsville, Maryland, where a small plot was "enriched" with about 500 pounds of typical western, silver-bearing rock fragments.

"Based on the principle of 'neutron activation analysis', the device hurls neutrons at the ground", said Senftle. "The neutrons enter the atoms of silver in the rock fragments, making them unstable and radioactive for about ten minutes. As the radioactive silver atoms disintegrate, they can be measured with a radiation detector", he explained.

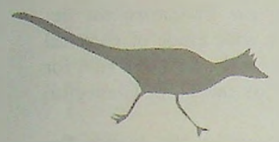
"The more silver there is in the ground target, and the more neutrons we bombard it with, the greater and more reliable the count of the radioactive silver atoms", the physicist explained.

During the short time the generator is on, it is operated remotely for safety reasons. However, the slight amount of radioactivity induced into the ground causes no safety problem.

In their field tests the Geological Survey scientists use a small trailer carrying the neutron generator and the radiation detector. The trailer is parked over the site to be tested, and remote controls are operated from a jeep a short distance beyond the area to be irradiated with neutrons. After the generator is turned on a minute or two, it is turned off, and the radiation detector is moved into position over the irradiated spot. The radiation from the silver atoms is then measured.

The "Silver Snooper" project is one of several steps taken by the U. S. Geological Survey to intensify its research program aimed at finding new silver resources.

MARY AUSTIN



A PAGE FROM HISTORY...

by ELISABETH L. EGENHOFF

At the end of a little side street in Independence in Inyo County, California, stands a small frame house under a huge willow tree. Before it is a plaque marking the spot (California Historical Landmark 229) as the home of Mary Austin, and quoting a bit from the *Preface* of her *Land of Little Rain*: "But if ever you come beyond the borders as far as the town that lies in a hill dimple at the foot of Kearsarge, never leave it until you have knocked at the door of the brown house under the willow-tree at the end of the village street, and there you shall have such news of the land, of its trails and what is astir in them, as one lover of it can give to another."

Mrs. Austin has long been gone from this place that she loved, and her eloquent tongue long stilled. But the products of her pen, strong with the unique strength that came to her through this desert land, still give us "such news...as one lover of it can give to another". Perhaps that strength made her the controversial woman that she became. Through it she conquered physical pain, sorrow, and a series of personal disasters and tragedies that would have beaten an ordinary mortal into the depths of despair; through it she made enemies that bore their bitterness long past her death. For it is said that when, in one of the desert communities, it was proposed that a fountain be erected to her memory—a low pool, where even the smallest creature might come to drink—the town officials summarily refused, so selfish, cruel, and mean was she thought to have been.

The "bare bones" of Mary Hunter Austin's life we present here. Those who wish to clothe them with flesh will find ample material in her autobiography *Earth Horizon*, published by Houghton Mifflin Company in 1932; in the biography *Mary Austin: Woman of Genius*, by Helen MacKnight Doyle, published by Gotham House, New York, in 1939; or in *The Beloved House*, by T.M. Pearce, published by the Caxton Printers, Ltd., Caldwell, Idaho, in 1940. Mary Austin herself speaks in innumerable essays, stories, articles poems, novels, books, and plays, a list of which may be found in *Mary Austin—Bibliography and Biographical Data*, edited by Joseph Gaer, a processed publication, SERA Project 2-F2-132 (3-F2-197), California Literary Research Monograph 2. *The Land of Little Rain*, reprinted in this issue of *Mineral Information Service*, is but a sampling; but it shows the quality of her work.

Born in Carlinville, Illinois, September 9, 1868, Mary Hunter—a precocious and nonconforming child from the very beginning—spent most of her first 20 years in that tight-bound midwest community. So uncongenial was her early life at times, hedged as it was by unfortunate family circumstances and nineteenth-century restrictions, that, when she was still a small child, she escaped to—or was joined by—"I-Mary", a second self never effectively challenged by other people, places, or events.

Before she was ten, she decided that her life work should be writing; in fact, by then she had started to write. Her interest in nature developed at an early age. When she was but twelve she read the Chautauqua course in geology, and that same year Hugh Miller's geological opus "Old Red Sandstone". Thus inspired, she began to collect fossils, particularly fossil cri-

Continued on page 207

Perhaps the most magnificent description of California desert country ever to reach print is Mary Hunter Austin's book, *The Land of Little Rain*. It includes the article of the same title reprinted herein, plus several other studies of the desert and its people: *Water Trails of the Ceriso, The Scavengers, The Pocket Hunter, Shoshone Land, Jimville—A Bret Harte Town, My Neighbor's Field, The Mesa Trail, The Basket Maker, The Streets of the Mountains, Water Borders, Other Water Borders, Nurslings of the Sky,* and *The Little Town of the Grape Vines.*

The first edition, published by Houghton, Mifflin and Co., in 1903, has long been out of print, and, in those libraries lucky enough to have it, is usually withdrawn to the rare-*Californiana* shelves. To our readers—to whom, we suspect, the desert is something more than the space separating Vegas from LA—we are pleased to say that a paperback reprint, cost 95¢, is now available as a volume in the Natural History Library, published by Doubleday & Company, in cooperation with the American Museum of Natural History. Malcolm C. McKenna, of the Museum's Department of Vertebrate Paleontology, has contributed a new foreword. The book can be ordered through your bookstore. It is not distributed by the Division of Mines and Geology.

THE LAND OF LITTLE RAIN

By Mary Austin

East away from the Sierra, south from Panamint and Amargosa, east and south many an uncounted mile, is the Country of Lost Borders.

Ute, Paiute, Mojave, and Shoshone inhabit its frontiers, and as far into the heart of it as man dare go. Not the law, but the land sets the limit. Desert is the name it wears upon the maps, but the Indian's is the better word. Desert is a loose term to indicate land that supports no man; whether the land can be bitted and broken to that purpose is not proven. Void of life it never is, however dry the air and villainous the soil.

This is the nature of that country. There are hills, rounded, blunt, burned, squeezed up out of chaos, chrome and vermilion painted, aspiring to the snow-line. Between the hills lie high level-looking plains full of intolerable sun glare, or narrow valleys drowned in blue haze. The hill surface is streaked with ash drift and black, unweathered lava flows. After rains water accumulates in the hollows of small closed valleys, and, evaporating, leaves hard dry levels of pure desertness that get the local name of dry lakes. Where the mountains are steep and the rains heavy, the pool is never quite dry, but dark and bitter, rimmed about with the efflorescence of alkaline deposits. A thin crust of it lies along the marsh over the vegetating area, which has neither beauty nor freshness. In the broad wastes open to the wind the sand drifts in hummocks about the stubby shrubs, and between them the soil shows saline traces. The sculpture of the hills here is more wind than water work, though the quick storms do sometimes scar them past many a year's redeeming. In all Western desert edges there are essays in miniature at the famed, terrible Grand Canyon, to which, if you keep on long enough in this country, you will come at last.

Since this is a hill country one expects to find springs, but not to depend upon them; for when found they are often brackish and unwholesome, or maddening, slow dribbles in a thirsty soil. Here you find the hot sink of Death Valley, or high rolling districts where the air has always a tang of frost. Here are the long heavy winds and breathless calms on the tilted mesas where dust devils dance, whirling up into a wide, pale sky. Here you have no rain when all the earth cries for it, or quick downpours called cloudbursts for violence. A land of lost rivers, with little in it to love; yet a land that once visited must be come back to inevitably. If it were not so there would be little told of it.

This is the country of three seasons. From June on to November it lies hot, still, and unbearable, sick with violent unrelieving storms; then on until April, chill, quiescent, drinking its scant rain and scanter snows; from April to the hot season again, blossoming, radiant, and seductive. These months are only approximate; later or earlier the rain-laden wind may drift up the water gate of the Colorado from the Gulf, and the land sets its seasons by the rain.

The desert floras shame us with their cheerful adaptations to the seasonal limitations. Their whole duty is to flower and fruit, and they do it hardly, or with tropical luxuriance, as the rain admits. It is recorded in the report of the Death Valley expedition that after a year of abundant rains, on the Colorado desert was found a specimen of Amaranthus ten feet high. A year later the same species in the same place matured in the drought at four inches. One hopes the land may breed like qualities in her human offspring, not tritely to "try," but to do. Seldom does the desert herb attain the full stature of the type. Extreme aridity and extreme altitude have the same dwarfing effect, so that we find in the high Sierra and in Death Valley related species in miniature that reach a comely growth in mean temperatures. Very fertile are the desert plants in expedients to prevent evaporation, turning their foliage edgewise toward the sun, growing silky hairs, exuding viscid gum. The wind, which has a long sweep, harries and helps them. It rolls up dunes about the stocky stems, encompassing and protective, and above the dunes, which may be, as with the mesquite, three times as high as a man, the blossoming twigs flourish and bear fruit.

There are many areas in the desert where drinkable water lies within a few feet of the surface, indicated by the mesquite and the bunch grass (*Sporobolus airoides*). It is this nearness of unimagined help that makes the tragedy of desert deaths. It is related that the final breakdown of that hapless party that gave Death Valley its forbidding name occurred in a locality where shallow wells would have saved them. But how were they to know that? Properly equipped it is possible to go safely across that ghastly sink, yet every year it takes its toll of death, and yet men find there sun-dried mummies, of whom no trace or recollection is preserved. To underestimate one's thirst, to pass a given landmark to the right or left, to find a dry spring where one looked for running water—there is no help for any of these things.

Photo by Mary Hill

Black Mountains, Death Valley National Monument.

Along springs and sunken watercourses one is surprised to find such water-loving plants as grow widely in moist ground, but the true desert breeds its own kind, each in its particular habitat. The angle of the slope, the frontage of a hill, the structure of the soil determines the plant. South-looking hills are nearly bare, and the lower tree-line higher here by a thousand feet. Canyons running east and west will have one wall naked and one clothed. Around dry lakes and marshes the herbage preserves a set and orderly arrangement. Most species have well-defined areas of growth, the best index the voiceless land can give the traveler of his whereabouts.

If you have any doubt about it, know that the desert begins with the creosote. This immortal shrub spreads down into Death Valley and up to the lower timberline, odorous and medicinal as you might guess from the name, wandlike, with shining fretted foliage. Its vivid green is grateful to the eye in a wilderness of gray and greenish-white shrubs. In the spring it exudes a resinous gum which the Indians of those parts know how to use with pulverized rock for cementing arrow points to shafts. Trust Indians not to miss any virtues of the plant world!

Nothing the desert produces expresses it better than the unhappy growth of the tree yuccas. Tormented, thin forests of it stalk drearily in the high mesas, particularly in that triangular slip that fans out eastward from the meeting of the Sierras and coastwise hills where the first swings across the southern end of the San Joaquin Valley. The yucca bristles with bayonet-pointed leaves, dull green, growing shaggy with age, tipped with panicles of fetid, greenish bloom. After death, which is slow, the ghostly hollow network of its woody skeleton, with hardly power to rot, makes the moonlight fearful. Before the yucca has come to flower, while yet its bloom is a creamy cone-shaped bud of the size of a small cabbage, full of sugary sap, the Indians twist it deftly out of its fence of daggers and roast it for their own delectation. So it is that in those parts where man inhabits one sees young plants of *Yucca arborensis* infrequently. Other yuccas, cacti, low herbs, a thousand sorts, one finds journeying east from the coastwise hills. There is neither poverty of soil nor species to account for the sparseness of desert growth, but simply that each plant requires more room. So much earth must be pre-empted to extract so much moisture. The real struggle for existence, the real brain of the plant, is underground; above there is room for a rounded perfect growth. In Death Valley, reputed the very core of desolation, are nearly two hundred identified species.

Above the lower tree-line, which is also the snow-line, mapped out abruptly by the sun, one finds spreading growth of piñon, juniper, branched nearly to the ground, lilac and sage, and scattering white pines.

There is no special preponderance of self-fertilized or wind-fertilized plants, but everywhere the demand for and evidence of insect life. Now where there are seeds and insects there will be birds and small mammals, and where these are, will come the slinking, sharp-toothed kind that prey on them. Go as far as you dare in the heart of a lonely land, you cannot go so far that life and death are not before you. Painted lizards slip in and out of rock crevices, and pant on

Photo by Mary Hill

Artist's Palette, Death Valley National Monument.

the white hot sands. Birds, hummingbirds even, nest in the cactus scrub; woodpeckers befriend the demoniac yuccas; out of the stark, treeless waste rings the music of the night-singing mockingbird. If it be summer and the sun well down, there will be a burrowing owl to call. Strange, furry, tricksy things dart across the open places, or sit motionless in the conning towers of the creosote. The poet may have "named all the birds without a gun," but not the fairy-footed, ground-inhabiting, furtive, small folk of the rainless regions. They are too many and too swift; how many you would not believe without seeing the footprint tracings in the sand. They are nearly all night workers, finding the days too hot and white. In mid-desert where there are no cattle, there are no birds of carrion, but if you go far in that direction the chances are that you will find yourself shadowed by their tilted wings. Nothing so large as a man can move unspied upon in that country, and they know well how the land deals with strangers. There are hints to be had here of the way in which a land forces new habits on its dwellers. The quick increase of suns at the end of spring sometimes overtakes birds in their nesting and effects a reversal of the ordinary manner of incubation. It becomes necessary to keep eggs cool rather than warm. One hot, stifling spring in the Little Antelope I had occasion to pass and repass frequently the nest of a pair of meadowlarks, located unhappily in the shelter of a very slender weed. I never caught them sitting except near night, but at midday they stood, or drooped above it, half fainting with pitifully parted bills, between their treasure and the sun. Sometimes both of them together with wings spread and half lifted continued a spot of shade in a temperature that constrained me at last in a fellow feeling to spare them a bit of canvas for permanent shelter. There was a fence in that country shutting in a cattle range, and along its fifteen miles of posts one could be sure of finding a bird or two in every strip of shadow; sometimes the sparrow and the hawk, with wings trailed and beak parted, drooping in the white truce of noon.

If one is inclined to wonder at first how so many dwellers came to be in the loneliest land that ever came out of God's hands, what they do there and why stay, one does not wonder so much after having lived there. None other than this long brown land lays such a hold on the affections. The rainbow hills, the tender bluish mists, the luminous radiance of the spring, have the lotus charm. They trick the sense of time, so that once inhabiting there you always mean to go away without quite realizing that you have not done it. Men who have lived there, miners and cattle-men, will tell you this, not so fluently, but emphatically, cursing the land and going back to it. For one thing there is the divinest cleanest air to be breathed anywhere in God's world. Some day the world will understand that, and the little oases on the windy tops of hills will harbor for healing its ailing, house-weary broods. There is promise there of great wealth in ores and earths, which is no wealth by reason of being so far removed from water and workable conditions, but men are bewitched by it and tempted to try the impossible.

You should hear Salty Williams tell how he used to drive eighteen- and twenty-mule teams from the borax marsh to Mojave, ninety miles, with the trail wagon full of water barrels. Hot days the mules would go so mad for drink that the clank of the water bucket set them into an uproar of hideous, maimed noises, and a tangle of harness chains, while Salty would sit on the high seat with the sun glare heavy in his eyes, dealing out curses of pacification in a level, uninterested voice until the clamor fell off from sheer exhaustion. There was a line of shallow graves along that road; they used to count on dropping a man or two of every new gang of coolies brought out in the hot season. But when he lost his swamper, smitten without warning at the noon halt, Salty quit his job; he said it was "too durn hot." The swamper he buried by the way with stones upon him to keep the coyotes from digging him up, and seven years later I read the penciled lines on the pine headboard, still bright and unweathered.

But before that, driving up on the Mojave stage, I met Salty again crossing Indian Wells, his face from the high seat, tanned and ruddy as a harvest moon, looming through the golden dust above his eighteen mules. The land had called him.

The palpable sense of mystery in the desert air breeds fables, chiefly of lost treasure. Somewhere within its stark borders, if one believes report, is a hill strewn with nuggets; one seamed with virgin silver; an old clayey water-bed where Indians scooped up earth to make cooking pots and shaped them reeking with rains of pure gold. Old miners drifting about the desert edges, weathered into the semblance of the tawney hills, will tell you tales like these convincingly. After a little sojourn in that land you will believe them on their own account. It is a question whether it is not better to be bitten by the little horned snake of the desert that goes sidewise and strikes without coiling, than by the tradition of a lost mine.

And yet—and yet—is it not perhaps to satisfy expectation that one falls into the tragic key in writing of desertness? The more you wish of it the more you get, and in the meantime lose much of pleasantness. In that country which begins at the foot of the east slope of the Sierra and spreads out by less and less lofty hill ranges toward the Great Basin, it is possible to live with great zest, to have red blood and delicate joys, to pass and repass about one's daily performance an area that would make an Atlantic seaboard state, and that with no peril, and, according to our way of thought, no particular difficulty. At any rate, it was not people who went into the desert merely to write it up who invented the fabled Hassayampa, of whose waters, if any drink, they can no more see facr as naked fact, but all radiant with the color of romance. I, who must have drunk of it in my twice seven years' wanderings, am assured that it is worth while.

For all the toll the desert takes of a man it gives compensations, deep breaths, deep sleep, and the communion of the stars. It comes upon one with new force in the pauses of the night that the Chaldeans were a desert-bred people. It is hard to escape the sense of mastery as the stars move in the wide clear heavens to risings and settings unobscured. They look large and near and palpitant; as if they moved on some stately service not needful to declare. Wheeling to their stations in the sky, they make the poor world-fret of no account. Of no account you who lie out there watching, nor the lean coyote that stands off in the scrub from you and howls and howls.

Mary Hunter Austin at the turn of the century. *Photo courtesy Eastern California Museum, Incorporated.*

Mary Austin, continued from page 202

noids. She soon, as she said, had a croquet box full, that was continually being dragged out for other young collectors to gloat over and everybody to stumble upon. Her most treasured fossil was a trilobite which she had acquired from a boy at school, after having reduced it in his own esteem by convincing him that it was not, as he had proudly believed, a petrified owl.

Mary Hunter's interest in the natural sciences lasted throughout her life. In 1888, when her family—then reduced to her mother and two brothers—moved to California and established themselves on a homestead at the far south edge of the San Joaquin Valley, she found country that stirred her strangely. A large part of her time, day and night, she spent out-of-doors, inquiring, observing, and recording for future use the habits of the night-prowling animals, the flux of seasons, the kinds of growing things, the movements of sheep and cattle, the stories of herders, Indians, pioneers—anything and everything that crossed her path. Mostly her mind was filled with questions; and for help in finding the answers, she turned to General Edward F. Beale, owner of Tejon Rancho, who was thoroughly familiar with the land and the sources of information about it, and glad to pass on his knowledge to the quick and intelligent girl.

Mary had time on her hands, for she was not "popular" with the "crowd"; in fact, they omitted to include her in their affairs when they could do so. And, though this was a blow to the pride of a young miss, it was not so shattering a thing as to hear her mother say, in terrible grief over the loss within a few months of both husband and younger daughter, "Why couldn't it have been Mary?" Mary found herself quite able to cope with unpopularity, and this, in turn, kept her even more alone.

By the summer of 1889 it was obvious to the Hunters that they would not be able to make the homestead pay. General Beale, as always sympathetic to the

Rose Station, Kern County. *Photo courtesy Tejon Ranch Co.*

problems of homesteaders, offered to let them work Rose Station, the old stage stop just below the Pass, on his Tejon Ranch. Mary spent but little time there, for she was almost immediately engaged to teach at Mountain View dairy ranch.

Here Mary Hunter came into her own. She was an excellent teacher, able not only to stimulate the interest and natural inquisitiveness of her students, but also to win their affection, even their devotion. Here, too, she met Stafford Wallace Austin and became engaged to him. They were married May 18, 1891, at her mother's home, which was then in Bakersfield.

Stafford Austin's goal, at the time he married Mary, was to become a vineyardist; it took him a little less than a year to lose that hope. Next, he and his brother Frank set up an irrigation project for the Owens Valley, which Stafford was to manage from Lone Pine; and, after a short interlude in San Francisco (during which Mary sold her first two short stories) husband and wife took up residence at the Lone Pine hotel.

Mary—now expecting a baby—found Lone Pine a congenial place: this in spite of the fact that within a few weeks the irrigation project followed the attempt at viticulture to oblivion. The Austins, being penniless, and not considered a very good risk, were barred from their hotel room. Mary, in sudden desperation, sought work as cook in a local boarding house patronized largely by miners recovering from lead poisoning (one of the hazards of the profession in that area), where she came to know them well. Though they were gentle and courteous to her, she said, she found them "less rewarding than other sorts of Westerners", because they were thoroughly preoccupied with four subjects: killings, hold-ups, rich strikes, and lost mines!

When the time for her child's birth drew near, Mary returned again to her mother's home: by stage south through Red Rock Canyon to Mojave, thence by the Los Angeles train north to Bakersfield. Because of her "condition" she was allowed to ride outside with the stage driver rather than in the stuffy coach—a position she found so advantageous for viewing the passing landscape and drawing out the driver's stock of local information, that on later journeys she wangled the same spot. In time, she was even allowed to take the reins. Fortunate it was, too; for a day came when the driver turned sick, and Mary of necessity took his place, leaving her baby to the care of a couple of men inside the coach.

Little Ruth arrived October 30, 1892, taking forty-eight hours to make up her mind that she really wanted to enter the world. Mary was ill for months thereafter; but a worse blow came to her just a few days after the birth of the child: everything relating to her marriage—and apparently a number of things before it—Mr. Austin had arranged on credit. Since the failure of his projects, he had been most of the time unemployed and therefore unable to pay; now she was besieged by his creditors. He, isolated at a mountain camp in Inyo, sent her word to take care of things as she saw fit, expecting, he later told her, that she would declare him bankrupt. But Mrs. Austin was made of tougher stuff: she settled with those people she could after selling the house and "vineyard"; the rest she arranged to pay in installments.

For several years thereafter she struggled to put their lives in order; but matters went from bad to worse. For awhile they settled at George's Creek, north of Lone Pine, where Mr. Austin taught school. The baby was sickly, and Mary herself ailing—but they made a few friends. The doctor from Independence stopped by frequently, out of the kindness of his heart and a yearning for a bit of intellectual stimulation; and an Indian *mahala*, who, pitying the scrawny infant and distracted young mother, nursed the child at her own breast. Ruth flourished, growing into a strong, beautiful, golden-haired baby; two or three years later, because she was not talking as early as she should, the *mahala* journeyed all the way to Lone Pine to bring her meadow-larks' tongues, that her speech might be quick and nimble.

During this period Mary became well acquainted with the Indians, going out occasionally to work with the women at their native tasks; learning how to make snares, to weave baskets, and to find the seeds used for food and the plants used for medicine. She challenged an eagle for a lake trout brought down by a flash flood in George's Creek, and almost had her baby snatched instead; but she fought off the immense bird with a hoe, and escaped with one long, raking scratch from his claws. She renewed her acquaintance with the flocks and herders she had known on the Tejon, and to the latter she brought garden greens and fresh garlic, which she traded for lumps of fresh mutton, and for news of the trail.

The next winter Mr. Austin taught school at Lone

Red Rock Canyon, Kern County. Mrs. Austin writes, of one of her stage trips through it: "I recall once setting out for Mojave at such an hour that midnight brought us to Red Rock Canyon, one of the weirdest wind-sculptured defiles of the West, with nobody on board but three or four nondescript male passengers and Mary on the boot beside the driver. Where we slowed down by the drag of the wind-sifted sand in the dark of the canyon, a figure moved mysteriously up on our right...the driver laid his hand warily on his hip and the stranger hastened to make known his quest...

'Ye got anybody on board that can pray out loud?'

The driver halted, gun-hand squared to the stranger's direction. Nothing came out of the interior but the sound of heavy breathing.

'We got a man here's pretty badly hurt,' apologized the interlocutor; 'he'd like to have somebody pray for him.'

After another dead interval, Mary leaned across the driver's knee. 'I could pray,' she said.

The dark stranger peered and hesitated. 'You're a lady, ain't ye? The man's pretty bad—'

'I got the mail,' the driver explained; 'I could wait fifteen minutes.'

Mary began to clamber down in the dark.

'Here you,' the driver called indignantly into the interior, 'ain't some o' you fellows goin' with the lady?'

Grunting, two male figures took form in the mitigated dark of the stage lantern; we followed the stranger around a coign of the canyon wall. There was a camp there and a low fire; a wagon bulked darkly and beside the fire the hurt man propped on a bedding roll under a blanket. 'Here's a lady come to pray with you, Bill.' Bill was evidently far gone. He tried to speak; tried to push back the blanket, which showed him bandaged about the breast. Another man came up from the wagon, carrying one of his arms awkwardly, muttering something. The guide put the blanket firmly back. 'Don't keep the lady waiting, Bill.' Mary caught the wandering feeble hands of the hurt man in hers...'Merciful Father...' she began; behind her she could see, or rather hear the men taking off their hats. There had been, Mary considered, some sort of a shooting scrap...no time to think of that... 'Repeat after me: Christ Jesus, forgive my sins...Jesus... forgive,' very faint; 'and receive my spirit...'

When we got down at Keeler the next afternoon, the two men who had stood behind Mary when she prayed came up solemnly and shook her by the hand. Later the driver told me that on his daylight trip back he had stopped long enough to visit the death camp, but besides the cold ashes he found no trace." [From *Earth Horizon*, by Mary Austin, Houghton Mifflin and Company, 1932, by permission of the publisher.]

The road through Red Rock Canyon is now multi-lane Highway 6, running southwest from Highway 395 to Mojave.

Photo by Mary Hill

Pine, where conditions were somewhat improved; at least the house was better, and his salary a bit larger. She was drawn once more into the company of miners and mining people, the tag ends of the Comstock rush, those "relicts of the great mining days, whose trails went up like smoke even as Mary watched them". She crossed the town's social borders, making friends with its Spanish-speaking population, learning from them the art of Mexican cooking and the sound of their soft-flowing language.

So her days went...until Mr. Austin took up a homestead in the Alabama Hills. Though she found great beauty in that spot, Mary was not there long, for the life was more taxing than her health could stand, and the strain was a hundredfold increased by her growing suspicion that Ruth was mentally afflicted. Short of money as always, she took Ruth and went to Bishop, to teach English in the Academy there. For the time, Mr. Austin stayed behind.

It is said that Mary lived in Bishop in abject poverty, leaving the child alone in the hotel when she had to; but saving, saving, saving against the day when she might be able to afford an operation that by chance might make the girl well. As it turned out, the hope was in vain, for Ruth Austin died in her twenties in an institution. Kindly neighbors attempted to care for the child, but the distraught mother, far from thanking them, scarcely noticed that they were there. Finally, in desperation, she placed Ruth with a nearby farm family, and devoted all her attention after school to her writing. This the townspeople took to be child desertion, and part of the adverse legend of Mary Austin took shape.

In 1897 Mr. and Mrs. Austin accepted work as teachers—he as Superintendent—in the Lone Pine school; but once more her health gave out, and she went to Los Angeles. Soon afterward Mr. Austin quit his job and moved to Independence to become Registrar of the Desert Land Office. Mary, not having been consulted, was incensed; but when she could she went to him there.

Even for Independence, Mary's particular brand of independence was too much. She managed to get herself read out of the Methodist Church there for teaching Higher Criticism to an adult Bible class, and she sadly strained the social proprieties when a chocolate cake she made turned up in the center of a mass of fire crackers and punk sticks at the local Chinese New Year celebration. Nor could many of the townspeople condone her taking part in Indian dances, or starting a community theater.

Another bout with illness sent her to Los Angeles for a year, where she had a chance to meet and talk with other writers for the first time in her career. She would undoubtedly have liked to stay, but Mr. Austin would not leave Inyo, so she returned there, feeling that another year of separation would probably end their marriage.

She wrote. *The Land of Little Rain* (of which she said, "I was only a month writing...but I spent twelve years peeking and prying before I began it") was published, and was an immediate success. She began

The land of little rain, near Bishop.

Photo by Mary Hill

California Historical Landmark 229, "the brown house under the willow tree", home of Mary and Wallace Austin in Independence. Mrs. Dorothy Cragen, Director of the Eastern California Museum, Inc., who kindly furnished this photo from the Museum's files, writes, "The house is going to be up for sale soon. It has been in private hands....We would like to have it preserved and open to the public sometime. Our Recreation Director is working on it for the Board of Supervisors...trying to get the Division of Beaches and Parks interested in it."

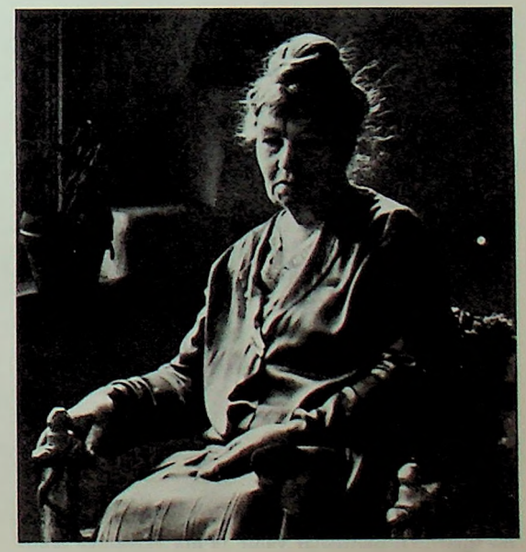
Those of our history-minded readers who have seen samples—such as the Chinese Joss House at Weaverville, the Vallejo Home at Sonoma, or the gold-discovery site at Coloma—of the superlative work of restoration and preservation done by our sister agency, the Division of Beaches and Parks, will realize the future worth of Inyo's project. Any word of encouragement you may give Mrs. Cragen will no doubt be greatly appreciated. She can be reached at the Inyo County Courthouse, Independence, California.

to build a reputation. People sought her out—geologists, collectors of Indian artifacts, botanists, explorers, Sierra Club members—because of her knowledge of the land. She was acknowledged an expert on Indian affairs; and no less personage than Theodore Roosevelt, President of the United States, sought her opinion on forest lands and grazing.

In the early 1900s Mary, planning her book *Isidro*, took the opportunity to travel to Monterey and do research for it at the Mission of Carmel. There she made the acquaintance of many prominent writers, and with Jack London, George Sterling, and several others, formed the artists' colony at Carmel.

But her time in California was now coming to its end. In 1903 an investigation was started by the National Reclamation Bureau to reclaim arid lands in Owens Valley. Individual owners made transfers of rights and privileges, and land was purchased easily by men who claimed to represent the Government. And then the rosy picture exploded. Word got round that the water was instead to be drained from the Valley to supply Los Angeles. Wallace and Mary Austin joined their protests to those of the Valley inhabitants—to no avail. Wallace Austin eventually moved on to Death Valley. Mary Austin resumed her writing—for a time—in Carmel. Ill and depressed, she foresaw nothing but desolation for the country of Inyo, and, loving it as she did, had no wish to return there.

Mary Austin came no more to the Land of Little Rain. Of her later life in Europe, New York, Santa Fe—her reputation for eccentricity, her fame as writer and lecturer, her championship of feminist causes, her deep interest in and sponsorship of Indian and Spanish-derived folk cultures, her reputation as prophetess and naturist, her mysticism, the personal serenity and sustaining religious belief she drew from the Land of Little Rain—no more need be said here. She lived 66 full years, years of meeting life head-on, years during which resignation was "never a character written in her book", before her death on August 13, 1934, at her "Beloved House", Casa Querida, in Santa Fe, New Mexico.



Mary Austin, 1932. Photo reproduced through the courtesy of Bancroft Library.

FROM OTHER PUBLISHERS

Alluvial fans in the Death Valley region, California and Nevada. By Charles S. Denny. U. S. Geological Survey Professional Paper 466. 1965. 62 pp. The author discusses the origin of desert pavement, as well as other geomorphic problems of the Death Valley area.

Desert peaks guide, Part 1. Edited by Walt Wheelock. 1964. 40 pp. Published by La Siesta Press, Box 406, Glendale, California, 91209. A guide to the climbing, with bits about the geology, of rocks in the White, Inyo, Coso, and Argus Ranges, as well as what are listed as "Mono Peaks".

Encyclopedia of buried treasure hunting. By Karl von Mueller. Published by Exanimo Press. 1965. 87 pp. Price $1.00. A collection of entries relating to prospecting and treasure hunting, alphabetically arranged. Included are such entries as "Pacific Palisades Treasure", "Lost Sheepherder Mine", and "Mineral Information Service", but not, oddly enough, "Captain Kidd".

A field guide to the gems and minerals of Mexico. By Paul Willard Johnson. Published by Gembooks, Mentone. California. 1965. 97 pp. Price $2.00.

Baja California overland. By L. Burr Belden. Published by La Siesta Press, P.O. Box 406, Glendale, California. 1965. 64 pp. Price $1.95.

Illustrations of the Huttonian theory of the earth. By John Playfair. Published by Dover Publications, Inc., New York. 1964. 528 pp. Price $2.75. A facsimile reprint of the edition of 1802, and a bargain for those interested in the history of science.

Third progress report to the Legislature, 1965 Regular Session. Section 1. By Senate Permanent Factfinding Committee on Natural Resources. 1965. Chapter 3 of this section is entitled, "Geologic needs of California", and concerns the program of this Division.

Natural gamma aeroradioactivity map of parts of the San Francisco region, California. By Kenneth G. Brooks. U. S. Geological Survey, Geophysical Investigations Map GP 483. 1965. Scale 1:250,000.

Radiative heat exchange in the atmosphere. By K. Ya. Kondrat'yev. Published by Pergamon Press (new address: 44-01 21st St., Long Island City), New York. 1965. 411 pp. Inasmuch as this subject is of considerable interest to physical scientists, this comprehensive volume should be of use to anyone concerned with the earth's physical conditions. This is the first English edition. It has been revised and enlarged by the author from his original Russian volume, "Radiant energy of the sun". Of particular value is his extensive bibliography.

Methods of determining E_h and pH in sedimentary rocks. By Gennadii Anatol'evich Solomin. Authorized translation from the Russian. Published by Consultants Bureau Enterprises, 227 W. 17th Street, New York. 1965. 56 pp. The author describes a method of determining the redox potential in sedimentary rocks. The redox potential (E_h) is a measurement determined by subjecting a redox system to conditions that cause the system to gain or lose electrons. The procedure involves the immersion of a noble metal electrode (generally platinum) in a solution containing a redox system. Redox systems are developed in those elements that are polyvalent: i.e., Fe···, Fe··, and the like. The author suggests a new method for determining the redox potential—relative to hydrogen as 0. Such new techniques can be of value in prospecting for ore deposits, as well as in understanding the principles involved in the alterations of rocks.

The use of surfactants in the petroleum industry. Edited by P. A. Rebinder. Authorized translation from the Russian. Published by Consultants Bureau Enterprises, 227 W. 17th St., New York. 1965. 346 pp. Price $45. In the past ten years, the Soviet Union has been doing considerable research and experimentation in the use of surface-active substances to increase petroleum recovery. Three conferences on the use of surfactants have been held in the Soviet Union, under the sponsorship of the USSR Academy of Sciences. This translation covers the second conference, augmented by papers from the first that English readers may not know. Proceedings from the third conference are now being prepared for publication in Russian. The publisher's staff has compiled a particularly useful table that forms a preface to the book. Entitled "Partial list of surfactants", it tells the reader what the various surfactants referred to are. Not all of them are known: for example, one of the unknown substances, called "bunigal", is not identified by chemical formula, and its identity is not known to the translator; another is called "Soviet Detergent", and only a guess can be made as to its composition.

Principles of structural glaciology. The petrography of fresh-water ice as a method of glaciological investigation. By P. A. Shumskii. Published by Dover Publications, Inc., New York. 1964. From the Russian by David Kraus. 497 pp. Price $3.00. Professor Shumskii defines glaciology as the study of all ice, not merely ice in glaciers. This book is a summary of work in the field of glaciology up to 1952, with additions, especially to the bibliography, to 1964.

REDDING QUADRANGLE MAP SHEET READY

Map Sheet 4, "Geologic map of the Redding quadrangle, Shasta County, California", is now ready for distribution. Like the previous three maps in the Map Sheet series, the Redding quadrangle map consists of a colored lithographed map and a text, printed together on one large sheet of paper.

The area of the quadrangle is 7½ minutes of latitude and longitude, extending from about the Sky Ranch Airport south of the city of Redding to the Keswick hydraulic pits north of Redding. East and west, the area covered is from approximately the Rodeo Grounds outside the city to about the Shasta State Historical Monument.

Rocks in the area are delineated in color. They range in age from Devonian, represented by the Copley Greenstone, through batholiths, stocks, and dikes of Jurassic or Cretaceous age, the Pliocene (?) Nomlaki Tuff and Pleistocene (?) Red Bluff Formation, to Recent gravel, sand, silt, clay, and soil.

The region is one of extensive mining, especially for gold, although copper, tungsten, and gravel have also been won. The locations of 34 lode gold mines, 21 placer mines, one tungsten and one copper mine, two sand and gravel and two stone quarries are plotted on the map.

The map was prepared by V. F. Hollister and J. R. Evans, and is published at a scale of 1:24000, or about 2½ inches to the mile. It is sold in a manila envelope similar to those of other map sheets. Price is $1.50, plus tax for California residents.

Redding and vicinity. View northwest toward Shasta Bally and Trinity Alps.

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