recorded at different concentrations, a gradual shift of the half-wave potential is observed with increasing concentration. This shift is entirely due to the increase of the iR factor, and for constant resistance the shift is a linear function of the current i. If the current values corresponding to the "half-wave voltages" are connected by a straight line, the intercept of this line with the voltage axis will be the true half-wave potential of the substance (Fig. 1); since at this point i is zero, iR must also be zero. The difference between the half-wave voltage and the thus determined half-wave potential for any particular curve will be the iR correction corresponding to the current value in question. It can readily be seen that if the resistance is kept constant, iR will depend solely on i.

Although the half-wave potential represents a convenient reference value to be used in constructing such a plot, it is emphasized that the same slope will be obtained if any other set of homologous points, that is, current values corresponding to some constant ratio of oxidant to reductant, are connected. The intercept with the voltage axis in such a case will be the electrode potential for that particular ratio. It follows, therefore, that *any* measured i value is displaced along the voltage axis by an amount iR, which is determined entirely by i.

If the iR factors thus determined are plotted against i (Fig. 2), the voltage correction can be read from the graph for any i value. Since only voltage differences are calculated in the evaluation of iR, the factors determined by this method are independent of the nature of the substance employed for the determination of the half-wave shifts; and as long as the resistance and the galvanometer sensitivity are constant, the factors are applicable to all current values. If the current is expressed in amperes, the slope of the iR/i plot will give the resistance of the circuit in ohms.

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Communications

Rare-Earth Mineral Deposits of the Mountain Pass District, San Bernardino County, California

Bastnaesite, a rare-earth fluocarbonate, was found in the Mountain Pass district in April, 1949. Subsequent geologic mapping has shown that rare-earth mineral deposits occur in a belt about 6 mi long and 1½ mi wide. One of the deposits, the Sulphide Queen carbonate body, is the greatest concentration of rare-earth minerals now known in the world.

The Mountain Pass district is in a block of pre-Cambrian metamorphic rocks, bounded on the east and south by the alluvium of Ivanpah Valley, and separated on the west from sedimentary and volcanic rocks of Paleozoic and Mesozoic age by the Clark Mountain normal fault; the northern boundary of the district is a conspicuous transverse fault. The pre-Cambrian metamorphic complex comprises a great variety of lithologic types.

The rare-earth-bearing carbonate rocks are spatially and genetically related to potash-rich igneous rocks of probable pre-Cambrian age that cut the metamorphic complex. The larger potash-rich intrusive masses, 300 ft or more wide, comprise one granite, two syenite, and four composite shonkinite-syenite bodies. One of the shonkinite-syenite stocks is 6300 ft long. Several hundred relatively thin dikes of these potash-rich rocks range in composition from biotite shonkinite through syenite to granite. Although a few thin fine-grained shonkinite dikes cut the granite, the mafic intrusive bodies generally are the oldest and granitic rocks the youngest. The potash-rich rocks are intruded by east-trending andesitic dikes and are displaced by faults.

Veins of carbonate rock are most abundant in and near the southwest side of the largest shonkinite-syenite body. Most veins are less than 6 ft thick. One mass of carbonate rock near the Sulphide Queen mine is 700 ft in maximum width and 2400 ft long. About 200 veins have been mapped in the district; their aggregate surface area is probably less than one-tenth that of the large carbonate mass.

The carbonate minerals, which make up about 60 percent of the veins and the large carbonate body, are chiefly calcite, dolomite, ankerite, and siderite. Other constituents are barite, bastnaesite, parisite, quartz, and small quantities of crocidolite, biotite, phlogopite, chlorite, muscovite, apatite, hematite, goethite, fluorite, monazite, galena, allanite, cerite, sphene, pyrite, chalcopyrite, tetrahedrite, malachite, azurite, strontianite, cerussite, wulfenite, aragonite, and thorite. The rare-earth oxide content of much of the carbonate rock is 5 to 15 percent; in some local concentrations of bastnaesite the rare-earth oxide content is as high as 40 percent.

The foliation and inclusions in the Sulphide Queen carbonate body, and the discordant contacts between this body and the gneissic wall rocks, show that the carbonate rock was intruded as a mass into its present position. Radioactive determinations on monazite from the Sulphide Queen carbonate body indicate a tentative age of 770 million to 1100 million years (pre-Cambrian), and the potash-rich rocks are at least as old, and thus are of pre-Cambrian age.

Because of structural reasons, as well as the pre-Cambrian age of the monazite, the rare-earth-bearing carbonate rock could not have originated as sedimentary limestone or dolomite of Paleozoic age or through assimilation of sedimentary rocks of Paleozoic age by the parent magma of the potash-rich rocks. It might have had a sedimentary origin in the pre-Cambrian gneissic complex as limestone or evaporite, subsequently modified and squeezed into discordance with the foliation of the metamorphic rocks. A magmatic origin of the rare-earth-bearing carbonate rock by differentiation of an alkalic magma from shonkinite to syenite to granite, with a carbonate-rich end product containing the rare elements, is in harmony with the field relations. This late differentiate might have been introduced either as a relatively concentrated magmatic fluid, highly charged with volatile constituents such as carbon dioxide, sulfur, and fluorine, or as a dilute hydrothermal fluid.

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Navajoite, a New Vanadium Oxide from Arizona

Navajoite, hydrated vanadium pentoxide, is a new mineral found in the Monument No. 2 mine, on the Navajo Indian Reservation, Apache County, Arizona, and named in honor of the Navajo Indians. The mine is in a vanadium-uranium deposit just north of Comb Ridge in Monument Valley. The ore occurs in a channel that is filled with Shinarump conglomerate (Triassic) and that extends down through the Moenkopi formation (Triassic) into the DeChelly sandstone member of the Cutler formation (Permian).

The mineral, navajoite, occurs in highly oxidized ore in one part of the Monument No. 2 mine. It impregnates conglomeratic sandstone and silty sandstone, forms seams in the sandstone and crescent-shaped coatings above and below pebbles, and fills small fractures in clay lenses. The associated minerals include only one with V^{+4} and V^{+5}, corvusite; the rest are fully oxidized: tyuyamunite, rauvite, hewettite, steigerite, and limonite.

Navajoite is dark brown, soft, and fibrous, with a silky luster and brown streak. The specific gravity measured on the Berman balance is 2.56. The mineral is optically biaxial, probably negative, has parallel extinction and α is 1.905 ± 0.003, β about 2.02, and γ slightly above 2.02, with pleochroism X yellowish brown, Y yellowish brown, and Z dark brown and parallel to the fiber length. The chemical analysis, by A. M. Sherwood, shows 71.68 percent V_2O_5, 3.08 percent V_2O_4, 3.58 percent Fe_2O_3, 20.30 percent H_2O, 1.20 percent SiO_2, 0.22 percent CaO, and a total of 100.06 percent, and it indicates the formula $V_2O_5 \cdot 3H_2O$. Navajoite is readily distinguished by x-ray powder pattern from hewettite and corvusite, which it may resemble in physical appearance. Although the silky fibers of navajoite are too small for single crystal x-ray study, a rotation photograph of a small bundle of fibers indicated that the unit cell length along the fiber is about 3.65 A (H. T. Evans, personal communication, 1953). A large-scale photograph of the zero layer, obtained by placing a fiber bundle in a powder camera and using chromium radiation, shows many lines. Study of the photograph indicates that the two axes other than the fiber length are not at right angles and that navajoite is probably monoclinic, with the fiber length parallel to the *b*-axis. The best graphical solution of lattice constants found by plotting the reciprocal lattice spacings of the *h0l* lines suggests that $a_0 = 17.43 \pm 0.1$ A, $b_0 = 3.65 \pm 0.05$, $c_0 = 12.25 \pm 0.1$, and $\beta = 97° \pm 30'$. This unit cell would hold approximately 6 formula weights of $V_2O_5 \cdot 3H_2O$.

Navajoite would be an excellent vanadium ore mineral because of its high vanadium content, but unfortunately the mineral is probably not abundant in the ores of the Colorado Plateaus. This is because V^{+5} readily combines with other elements such as Ca, K, Na, Mg, Fe, Al, and U that are commonly present in the ore and because the hydrated vanadium pentoxide may form only under unusually acid conditions.

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Studies of River Morphology

A number of generalizations concerning the behavior and natural characteristics of river channels have been developed by the U.S. Geological Survey in several recently completed studies of river morphology. Measurements of parameters such as the discharge, suspended load, bed material, velocity of flow, channel slope, and channel shape indicate that many river channels are characterized by an orderly, progressive change of these variables from their headwaters to their mouths. The interaction of the variables and the establishment of a stable channel suggest that the morphology of the stream is controlled by a kind of equilibrium.

This concept of the interaction of a number of variables constituting a kind of equilibrium is the basis of present studies of the origin and operation of meanders, braids, and straight channels. These studies are in four principal parts:

(1) From field measurements of the aforementioned parameters, an effort is made to separate (isolate) the distinguishing physical features of each pattern. For example, in addition to their characteristic islands, braided streams frequently have steeper slopes, wider and shallower channels, and coarser bed material. On the other hand, detailed studies reveal marked similarities in the profiles and patterns of flow in meanders and straight channels.

(2) To understand the mechanics controlling the meander pattern, measurements are being made of the distribution of velocity and discharge in successive cross sections in the direction of the flows.

(3) Where possible, model studies supplement the