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PRELIMINARY REPORT ON TITANIUM-BEARING SANDSTONE IN THE SAN JUAN BASIN AND ADJACENT AREAS IN ARIZONA, COLORADO, AND NEW MEXICO

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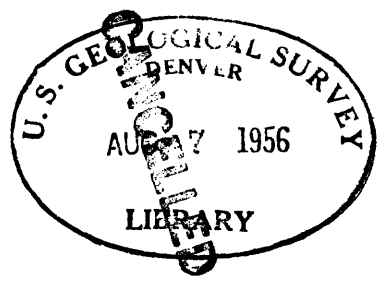

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During 1955 and part of 1956, 31 deposits of radioactive titanium-bearing black sandstone were reported in northwestern New Mexico, southwestern Colorado, and northeastern Arizona. Reconnaissance examinations have now been made of most of these deposits and laboratory studies are being undertaken to determine more conclusively the mineralogy of the deposits. Most of the black sandstone was located by airborne radiation detection equipment operated by personnel of the U. S. Atomic Energy Commission. Of the 31 deposits, 3 are found in the Pictured Cliffs sandstone, 21 in the Point Lookout sandstone, 1 in the Dalton sandstone member of the Crevasse Canyon formation, 3 in the Gallup sandstone, and 3 in the lower sandstone member of the Toreva formation. The locations of the black sand deposits are shown on the accompanying index map.

All of the sandstone units that contain black sand concentrations were laid down as littoral-type deposits during regressive stages of the Late Cretaceous sea. To date no deposits have been reported in sandstone laid down during a transgressive stage.

The black sand concentrations found in New Mexico, Colorado, and Arizona are mineralogically and environmentally the same as those described in Wyoming and Montana in the following references:

Houston, R. S., 1955, Petrography of Wyoming titaniferous sandstones (Abstract): Geol. Soc. Amer. Bull., v. 66, n. 12.

Murphy, J. F., 1955, Titaniferous sandstone of Wyoming and adjacent areas (Abstract): Geol. Soc. Amer. Bull., v. 66, n. 12.

_____, and Houston, R. S., 1955, Titanium-bearing black sand deposits of Wyoming: Wyo. Geol. Assoc. 10th Ann. Field Conf. Guidebook, p. 190-196.

Deposits in the Pictured Cliffs sandstone.—Three deposits are known in the Pictured Cliffs sandstone on Chacra Mesa in the southeastern part of the San Juan Basin. These are located on the ranch of Mr. L. L. Farr and were found by Mr. Farr by private aero-radiometric reconnaissance. The titanium-bearing sandstone deposits crop out as ridge-forming remnants lying at the top of the Pictured Cliffs sandstone which caps the mesa over a large area. Two of these deposits were visited and sampled for chemical analyses. The largest of these is about 3500 feet long and about 150 feet wide. Private drilling information indicates an average thickness of eight feet. A single sample taken about two feet below the top of the largest deposit contains 10.23 percent TiO_2 and 12.98 percent Fe_2O_3. Chemical analyses and spectrographic analyses of other samples from this deposit are pending.

The deposits in the Pictured Cliffs sandstone were laid down during the last major regression of the Late Cretaceous sea. Other known deposits accumulated at the time of this general regression are those in the Horsethief sandstone of northwestern Montana and in the Lewis shale of the eastern Wind River Basin, Wyoming.

Deposits in the Point Lookout sandstone.—Almost all of this group of deposits are found in the northwestern part of the San Juan Basin of New Mexico and Colorado. Exceptions to this are deposits found in the southeastern corner of the Navajo Indian Reservation and in the west-central part of Sandoval County, New Mexico. All of this group of deposits examined to date lie at the top of the Point Lookout sandstone and are directly overlain by the coastal swamp type of deposits of the Menefee formation. The black sand bodies range from isolated erosional remnants about 100 feet in diameter to large lenses more than two miles in length. The thickness of the exposures ranges from two to eight feet. The maximum exposed width is 250 feet. Many of the black sand deposits are so concentrated within small areas that economically they could be considered as single deposits.

No chemical analyses are completed of samples collected during the field investigation, but a random sample previously submitted by Mr. W. L. Chenoweth of the Atomic Energy Commission contains 21.5 percent TiO_2.

On an environmental basis the titaniferous sandstone deposits in the Point Lookout sandstone can probably be correlated with those in the Virgelle sandstone of northwestern Montana, the basal white sandstone of the Mesaverde formation of the Bighorn Basin, Wyoming, the basal unit of the Ericson sandstone of Clay Basin, Wyoming, and with those in the Pine Ridge sandstone member of the Mesaverde formation of the Laramie Basin, Wyoming. Each of these stratigraphic units was deposited as a regressive sandstone during the same major subsidence of the Late Cretaceous sea.

Deposits in the Dalton sandstone member of the Crevasse Canyon formation.—This deposit was not included in the field investigation, but its stratigraphic position in the upper part of the Dalton sandstone member was reported by Mr. R. B. O'Sullivan of the U. S. Geological Survey who accompanied Mr. Chenoweth to the deposit. Hand samples were submitted by O'Sullivan and Chenoweth and have been identified as titaniferous sandstone but no quantitative analyses have been completed.

Deposits in the Gallup sandstone.—To date three titanium-bearing sandstone deposits have been found in the Gallup sandstone. The deposits are located at Sanostee, Toadlena, and about six miles southwest of Gallup, New Mexico.

The Sanostee and Toadlena deposits have been systematically sampled but analyses are not completed. A sample of the Toadlena deposit previously submitted by Mr. Bryan Archer of the A. E. C. contains 32.0 percent TiO_2. The Toadlena deposit is about 1500 feet long and ranges from two to eight feet thick. The width is not exposed owing to steeply dipping beds. The Sanostee deposit is about 8000 feet long, 600 feet wide, and attains a maximum thickness of about 12 feet. Both the Sanostee and Toadlena deposits lie at the top of the basal sandstone unit of the Gallup sandstone and are overlain by carbonaceous shale and very coarse grained arkosic sandstone. The locality near Gallup was not included in the field investigation, but has been reported as titaniferous sandstone by Mr. J. E. Allen of the New Mexico Bureau of Mines and Mineral Resources.

No other black sand deposits have been found in any sandstone tongue known to be the equivalent of the Gallup sandstone.

Deposits in the Lower sandstone member of the Toreva formation.—Only widely scattered thin concentrations of black sand have been found in the Toreva formation of the Black Mesa Basin in northeastern Arizona. These deposits are worthy of mention only because they broaden the area of possible new deposits, and because they may indicate more extensive lower grade deposits.

The largest of these deposits is in Apache County about five miles north of Black Mountain Trading Post in an unnamed east-trending tributary of Burnt Corn Wash. In this deposit very thin black sand laminae are intercalated throughout a 13-foot section of littoral-type cliff-forming sandstone. The laminae can be traced intermittently along the cliff on the south side of the Canyon for about a mile.

A deposit, which is considerable more concentrated but very small in extent, is located about nine miles north-northwest of Black Mountain Trading Post in an east-trending tributary of Tah Chee Wash. The exposure is about six inches thick and less than 50 feet in diameter of outcrop. The deposit caps a coarse-grained cliff-forming sandstone on the north side of the canyon.

A small lens of black sand is exposed in a north-trending tributary of Oraibi Wash about 10 miles north of Pinon Trading Post in Navajo County. This lens is less than one inch in thickness and about one foot in length and is listed inasmuch as it represents the westernmost known occurrence of black sand in this region.

No chemical analyses of samples from the Toreva formation have been completed, but mineralogical determinations indicate that the titanium-bearing sandstone contains the same mineral assemblage as the more extensive higher grade deposits in the San Juan Basin.

All of the well-exposed titaniferous sandstone bodies examined in New Mexico and southwestern Colorado are elongate lenses and have northwest-striking long axes. They are thus parallel to the assumed strike of Late Cretaceous strand lines in the San Juan Basin.

General lithologic and mineralogic description.—The titanium-bearing sandstone consists largely of a very fine grained assemblage of heavy minerals. Quartz and other common rock-forming minerals make up a relatively small percentage of the rock. The black sand deposits are usually well-cemented with hematite and carbonates, and being resistant to erosion usually cap mesas and hogbacks. They are reddish brown to purplish maroon at the surface, but the color is due, in part, to intense oxidation and desert varnish. In recently exposed prospect pits the altered rock is rust-brown and the unaltered rock is black.

Bedding planes in the black sand deposits are obscure except where there is a marked change in the abundance of heavy minerals. Cross lamination is common where bedding can be detected, but larger scale cross-bedding is apparently a feature common only to rock of lower concentration of heavy minerals. The titaniferous sandstone has a characteristic flaggy to blocky fracture.

The sorting in these deposits is very good; histograms show a distinct peak at the 1/16 mm. size. The heavy minerals vary in degree of roundness and sphericity, but the majority are well-rounded with moderate sphericity.

X-ray and petrographic analyses show the titanium to be contained in ilmenite, anatase, rutile, and, in some samples, brookite and leucoxene. The most common minerals contained in the black sand are, in order of decreasing abundance, ilmenite, zircon, and garnet. Monazite and tourmaline are common in some deposits but are absent in others. Other heavy minerals present in the deposits are magnetite, spinel, and possibly staurolite.

Very little magnetite is found in the deposits, either as discrete grains or as exsolution intergrowths with ilmenite. This factor is of considerable economic importance as the relative absence of magnetite would greatly facilitate beneficiation of the rock for titanium.

There are at least four, and in some samples, five, varieties of zircon present which make up a very significant percentage of the black sand. The zircon contains a small quantity of uranium which, in part, accounts for the radioactivity. Monazite and radioactive unidentified opaque minerals account for the remainder of the radioactivity.

Ilmenite in the samples from Arizona is relatively fresh and unaltered. The ilmenite in the remainder of the samples appears to be more highly altered than the ilmenite in the black sand of Montana and Wyoming. Hence, there is undoubtedly a greater relative enrichment of TiO_2.

The results of this preliminary investigation are encouraging and indicate that further exploration should be undertaken to establish possible reserves, particularly for titanium and zirconium.