STATE OF ARKANSAS

Arkansas Resources And Development Commission

Hendrix Lackey, Executive Director

DIVISION OF GEOLOGY

Harold B. Foxhall, Director

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TITANIUM IN SOUTHERN HOWARD COUNTY, ARKANSAS

By

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ABSTRACT

The occurrence of ilmenite sand concentrations in southern Howard County, Arkansas near Mineral Springs was first reported in 1938. The known occurrences as well as the surrounding area were examined during the summer of 1946 and samples from several localities in the area were checked, both chemically and microscopically. The field and laboratory findings indicated that small amounts of ilmenite may be found disseminated in the sand members of the upper part of the Tokio formation in an area of about six square miles just northwest of Mineral Springs. Within this area there are small local concentrations of ilmenite on the Beulah Green and Pink Green properties. Some monazite was associated with the ilmenite at these two properties, but in such minute amounts as to be of no economic interest. The field evidence and development work to date indicate that even on the Green properties there is only a small proven tonnage of ilmenite-bearing sand and that more reserves would have to be developed before a mining operation could be considered

INTRODUCTION

Purpose and Scope of the Project

The investigation of the ilmenite sands in southern Howard County, Arkansas was undertaken by the Geology Division because of the present heavy consumption of ilmenite in the manufacture of white paint pigments and a report that the Howard County deposits were very extensive.

Location, Extent and Accessibility of the Area

This investigation covered an area (fig. 1) of about six square miles directly northwest of the community of Mineral Springs, Arkansas. State highway No. 27 crosses the south end of the area, and Mineral Springs is served by the Graysonia, Nashville, and Ashdown railroad.

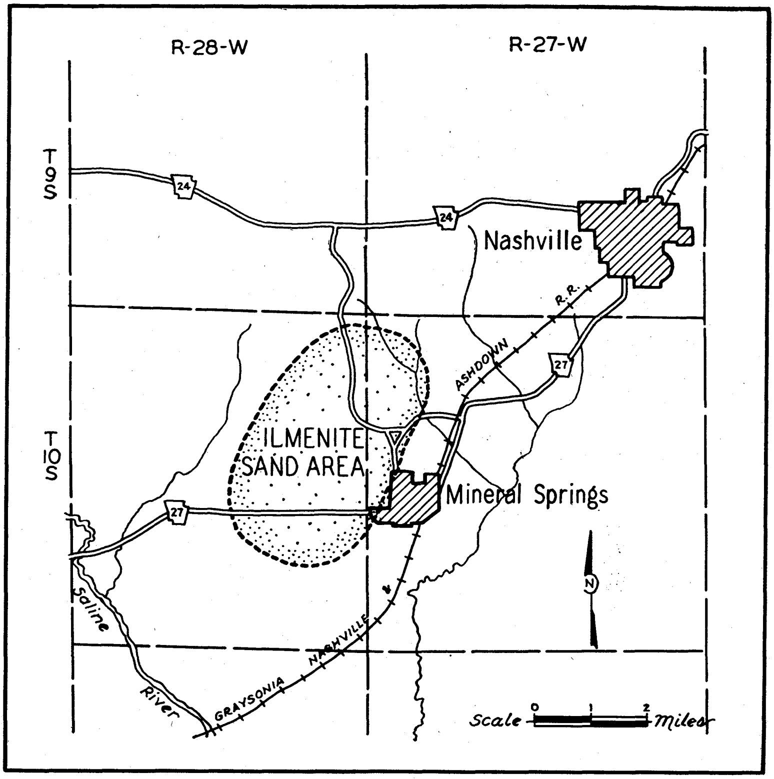

Fig. 1—Index map showing location of the Howard County ilmenite sand area.

Previous Investigations

The only publication on the geology of the Mineral Springs area is Arkansas Geological Survey Bulletin No. 1, "Upper Cretaceous Formations of Southwestern Arkansas," by Carl Dane, published in 1929. Although this bulletin does not describe the ilmenite sands in particular, it does contain a good description of the character, and structure of the Upper-Cretaceous formations as well as a geologic map showing their distribution.

The ilmenite sands were first noticed by King Rankin of Nashville, Arkansas, while prospecting for the State

Mineral Survey in 1938. In 1941 a special examination was made of the Pink Green property by the State Mineral Survey and a brief report, on file at the Division of Geology office, was written but never published.

In 1943 the U. S. Bureau of Mines made a study of the Pink Green and Beulah Green deposits during which samples were collected from auger holes, domestic wells and road cuts. Pertinent factual data from their investigation is included in this report.

Methods of Investigation

Numerous outcrops in the vicinity of Mineral Springs, other than those on the Pink Green and Beulah Green property were examined during the course of the investigation by the Division of Geology. Because of the low relief of the area, good exposures were limited to creek beds and road cuts. Sampling was based on the occurrence of ilmenite concentrations in the ditches adjacent to the outcrops. A channel sample was taken of the ilmenite-bearing sand exposed in the road cut on the Pink Green property, and an auger hole was drilled on the Beulah Green property to obtain samples, as there were no good exposures on the latter property. To check the persistence of the ilmenite sands down-dip, samples were collected from the Henderson water well that was being drilled just ½ mile south of the Beulah Green property at the time of the investigation. All samples collected were examined microscopically by the writer and chemical analyses on them were made by Troy W. Carney, Division of Geology chemist.

GENERAL GEOLOGY

With the exception of Recent alluvium and Pleistocene terrace deposits, the formations exposed in southern Howard County are all of Upper Cretaceous age. These formations are known to dip S.S.E. at a low angle, about 65 to 80 feet per mile, even though their trends are difficult to determine in individual out-crops. Ilmenite concentrations apparently occur only within the Tokio formation, which lies below the Brownstown marl and above the Woodbine formation. Its thickness in Howard County according to Dane is about 300 feet, and it is composed of intertonguing beds of gray clay, quartz sand, lignite, ferruginous, cross-bedded sands, and sandy clays. The following geologic column shows the relative position of the Tokio formation:

Age	*Formation*
Recent	Floodplain deposits
Pleistocene	Sand and gravel terraces
Eocene	Midway formation
Upper Cretaceous (Gulf Series)	Arkadelphia marl Nacatoch sand Saratoga chalk Marlbrook marl Annona chalk Ozan formation Brownstown marl Tokio formation Woodbine formation
Lower Cretaceous (Comanche Series)	Kiamichi clay Goodland limestone Trinity formation

The ilmenite deposits occur near the top of the Tokio formation since they are exposed near the Brownstown marl contact.

DESCRIPTION OF INDIVIDUAL DEPOSITS

As has been previously noted, some sampling was done by the writer in the Mineral Springs area outside of the boundaries of the two known deposits. None of these samples contained significant amounts of ilmenite as the following analyses indicate:

Sample	*TiO_2 Per Cent*
A	0.88
B	1.45
C	1.13
D	0.53
E	2.70
F	0.66
G	0.66

The location of the above samples have been plotted on Plate I.

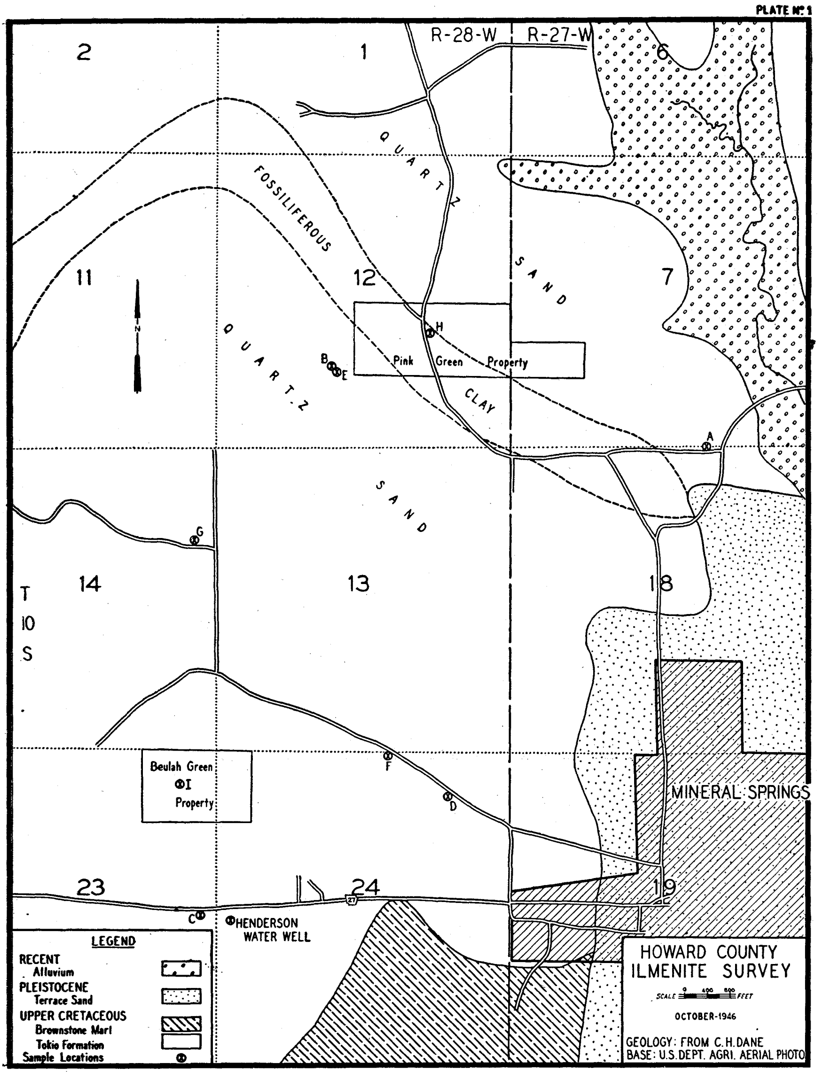

Plate I—Sketch Geologic Map of the Howard County Ilmenite Deposits.

The Pink Green Deposit

Ilmenite was first observed in place on the Pink Green property, which is located about 1½ miles northwest of Mineral Springs. A road cut crossing the center of the property exposes ilmenite-bearing sands and sandy clays just south of a small creek bed. The length of this exposure along the road is about 200 feet. The analyses of the samples from this road cut and from the well and auger hole on the property obtained by the Bureau of Mines are as follows:

Location	Sample No.	Interval Sampled in Feet	Analysis Per Cent					
			TiO_2	Fe	Cr_2O_3	Mn	V_2O_5	Mg
Channel sample from road cut	19	4-8	4.75	4.75	.035	.15	.003	2.26
Channel samples from well	35	0-5	7.01					
	36	5-10	2.19					
	37	10-15	0.65					
Samples from an auger hole	38	0-1	0.66					
	39	1-2	1.28					
	40	2-3	4.13					
	41	3-4	3.84					
	42	4-5	4.07					
	43	5-6	1.66					

An eight-foot section was sampled in this same road cut by the writer from the top of the bank to the bottom of the drainage ditch (map location "H"). The analyses and sample descriptions follow:

Depth in Feet	*Sample Description*	*TiO_2 Per Cent*
0-1	Buff, sandy surface soil	1.4
1-3½	Red and yellow sandy clay	2.2
3½-4	Medium-grained red sand, bearing ilmenite	12.8
4-5	Interbedded red, sandy clay, red sand, and gray clay	5.4
5-6½	Interbedded red sand and gray clay	3.9
6½-8	Friable coarse sand with lignitic streaks	7.2

It may be noted that the four to eight-foot interval (4.75 per cent TiO_2) sampled by the Bureau of Mines compares favorably to an average TiO_2 content of 4.5 per cent for the corresponding section sampled by the writer. Where ilmenite is visible in the section (3½ to 4 feet) it occurs in the laminae of a cross-bedded, friable sand. Analyses indicate that it also occurs in the clay. The well on the property which was sampled by the Bureau of Mines and showed a small percentage of titania was inaccessible at the time of the recent investigation by the writer. The only other significant occurrences of ilmenite observed on the property were the surface concentrations found along the banks of the stream previously mentioned. These concentrations are doubtlessly residual from the eroded ilmenite-bearing sands and sandy clays. Just a few hundred feet to the west of the Pink Green property along a slope where erosion has cut deep vertical gullies, is a thick, heavy, gray surface sand similar to the surface sand in the vicinity of the Beulah Green property. A channel sample (E) taken of this sand from the surface to a depth of four feet analyzed 2.7 per cent titania, and ilmenite concentrations were plainly visible on the gully floors.

A portion of the channel sample taken in the road cut at the 3½ to 4 foot interval was washed, screened, and examined microscopically. It consisted primarily of quartz and ilmenite grains both of which were coated with a white opaque cement probably silica. Small amounts of ferruginous cement partially covered the white coating on the grains. Both ilmenite and quartz grains were variable in size, the shape of the ilmenite being subrounded, the quartz, subangular.

The Beulah Green Deposit

The Beulah Green property located one mile west of Mineral Springs contains the best deposit of ilmenite now known in the area. In the west central portion of the property is located the only ilmenite concentration which might be called a "black sand." This black sand is a surface concentration in a plowed field and is only a few square yards in extent. Microscopically the sand is composed of highly-polished clean grains of ilmenite, quartz, and a few grains of monazite. Soil concentrations of ilmenite in the areas adjacent to the black sand are sufficient to give a pepper-and-salt effect to the buff gray surface sand. Residents of this locality state that ilmenite is particularly prominent after a rain and will be easily visible in the soil where its concentration is so low that it is obscured by dust during dry weather. The Bureau of Mines did most of their auger drilling and some test pitting on this property. The analyses of their drill hole samples follow:

Auger Hole No.	Sample No.	Interval Sampled in Feet	Analysis Per Cent					
			TiO_2	Fe	Cr_2O_3	Mn	V_2O_5	Mg
(1)	1	0-1	6.81	6.50	0.038	0.15	.001	1.81
	2	1-2	6.60	7.75	.020	.15	.001	2.15
	3	2-3	18.90	11.50	.058	.40	.002	1.76
	4	3-4	28.64	15.50	.039	.55	.001	2.17
	5	4-5	11.68	10.00	.019	.20	.001	1.23
	6	5-6	3.15	5.75	.058	.15	.003	1.63
(2)	7	0-1	5.50	5.50	.077	.15	.004	1.03
	8	1-2	2.82	3.25	.038	.10	.002	0.81
	9	2-3	1.93	3.00	.019	.05	.001	1.01
	10	3-4	1.16	2.00	.039	.05	.002	0.74
	11	4-5	0.90	1.75	.037	.03	.001	1.00
	12	5-6	0.64	2.50	.017	.03	.001	1.65
(3)	13	0-1	7.77	7.50	.038	.25	.002	1.23
	14	1-2	6.36	6.75	.058	.25	.004	1.92
	15	2-3	7.51	8.25	.017	.25	.001	2.28
	16	3-4	9.72	9.25	.018	.15	.001	1.48
	17	4-5	3.74	7.00	.036	.15	.002	1.72
	18	5-6	3.11	7.75	.017	.05	.001	1.81
(4)	23	0-1	9.05					
	24	1-2	20.27					
	25	2-3	6.41					
	26	3-4	5.05					
	27	4-5	11.68					
	28	5-6	3.09					
(5)	29	0-1	2.03					
	30	1-2	0.72					
	31	2-3	0.70					
	32	3-4	0.68					
	33	4-5	1.66					
	34	5-6	0.58					

During the investigation by the Division of Geology an auger hole was drilled (map location "I" on the Beulah Green property a hundred feet north of the "black sand" locality in order to obtain samples of ilmenite in place. The samples were described and analyzed as follows:

Depth in Feet	*Sample Description*	*TiO_2 Per Cent*
0-1½	Buff topsoil (6 inches) and red clayey sand	5.2
1½-3	Red clayey sand with red clay seams	5.5
3-4	Red clay and red and brown sand	10.9
4-5	Brown, red, and white clayey sand	12.3
5-6	Hard yellow sand and sandy red clay	9.8
6-7	Brown and red clayey sand	4.0

Note: Hole was bottomed in a very fine-grained gray clay.

The topsoil on the Beulah Green deposit, composed essentially of medium-grained gray quartz sand, was probably originally argillaceous, most of the clay having been washed out. The depth to compact argillaceous sand was checked in several places and found generally not to exceed the depth of cultivation. A portion of the sample representing the four to five foot depth in the auger hole was washed, screened, and examined microscopically. As in the case of the Pink Green sample examined, the sand was mostly ilmenite and quartz. Siliceous and ferruginous coatings on the grains were, however, much less prominent in the Beulah Green sand. To determine whether or not the black minerals were partly magnetite, a heavy liquid separation was made of the Beulah Green sand. The bulk of the heavy fraction was composed of black, opaque, minerals with a few grains of zircon, monazite, and contaminating quartz. Results of a magnetic separation test on the heavy minerals indicated that less than 5 per cent of the opaque minerals were magnetite.

As a check on the areal continuity of the Beulah Green ilmenite, cuttings were examined from the Henderson water well (see Plate I) that was drilled one-half mile to the south of the Beulah Green deposit. The well was logged and sampled by Mr. J. C. Brice of the Division of Geology at five-foot intervals to a depth of 80 feet as follows:

Depth in Feet	*Sample Description*
0-5	Reddish, clayey topsoil
5-10	Red brown sandy clay
10-20	Gray iron-stained plastic clay
20-25	Clay and coarse sand
25-30	Dark gray and brown clay, lignite
30-32	Fine quartz sand, bearing clay and ilmenite grains
32-35	Fine quartz sand, bearing clay and ilmenite grains
35-40	Fine-grained light brown and medium gray clays, lignite, ilmenite
40-45	Greenish sandy material appearing to be volcanic tuff, gray clay
45-50	Gray clay, greenish sandy material
50-55	Light gray plastic clay
55-70	Gray plastic clay
70-75	Light buff clay
75-80	Brown and light buff clay

Ilmenite was first encountered at a depth of 30 feet and was identified through 35 feet. The contamination of samples with lignite below 35 feet made the recognition of ilmenite uncertain below that depth. Unwashed samples from 30 to 32 feet (sample 720-A) and from 32 to 35 feet sample 720-B) showed titania contents of 2.44 per cent and 3.84 per cent respectively. A screen analysis was made of both samples, and both microscopic and chemical analyses of the screen fractions indicated that most of the ilmenite occurred in a size range from -100 to -150 mesh. The microscopic examination further showed that the sand was similar to that of the Pink Green and Beulah Green properties with two exceptions. A few grains of pyrite were noted in samples 720-A and B, and the ferruginous and siliceous coatings on the ilmenite and quartz grains were almost entirely absent. It is possible that these coatings may be related to surface solutions. Assuming an average dip of 72 feet per mile for the strata in this locality, ilmenite should have been encountered at a depth of 36 feet. Both the initial appearance of ilmenite at a depth of 30 feet in the well and the lithologic similarities previously noted show a strong correlation between the Beulah Green ilmenite and that in the Henderson well.

EXTENT OF THE DEPOSITS

The sediments of the Tokio formation, although considered to be marine in origin, probably were deposited in a near-shore environment. The ilmenite sand concentrations may represent the reworking of sands along ancient beaches. If such is the case, the ilmenite deposits then would be scattered over a large area, but individual deposits would probably be discontinuous. These relationships have been borne out by the field evidence available. To attempt to predict the extent of an individual deposit, particularly by surface indications of ilmenite, would be fruitless. By using the surface indications plus the regional strike and dip of the formations as a guide for drilling and sampling, the ilmenite-bearing sands and sandy clays can best be outlined. The field evidence and development work to date indicate that the known deposits of potential ilmenite ore are not extensive.

ECONOMIC ASPECTS OF THE DEPOSITS

With the meager data available, no estimate of the available tonnage of ilmenite can be made. Definitely, before a mill is considered, an extensive exploration program should be conducted to prove sufficient ore reserves. Such development could be accomplished by a combined drilling and test-pitting program. The drilling would determine the extent and grade of the ore, and if then justified, test-pitting would supply sufficient ilmenite sand to determine the milling characteristics.

Mining of the ore would not constitute a problem since it is relatively loosely consolidated and occurs at the surface. Open pit methods could be used employing bulldozer, scraper, dragline, or power shovel.

Preliminary ore dressing tests on the ilmenite-bearing sands conducted by the Bureau of Mines at College Park, Maryland and at Salt Lake City indicated that a concentrate containing 54.8 per cent TiO_2 could be made, however no flow sheet is available on the procedures used by the Bureau. The Humphreys Spiral Concentrator which has recently become important in the concentration of the beach-sand type of ore would probably be applicable to this ore. Since the ore is not essentially a beach sand, however, some washing to remove clay and perhaps, crushing to handle the partially indurated sand would be required. Electricity, natural gas, and railroad service are all available at Mineral Springs. The problem of water supply for a mill, however, would require serious consideration. Even though southern Howard County is known as an area of very productive water wells and a flowing well has been drilled in the town of Mineral Springs, the water requirements for a milling operation are considerable and a water well supply might not suffice.

Much interest was aroused in the Howard County ilmenite deposits when it was found that the ores were very feebly radioactive. This slight radioactivity is doubtlessly due to the presence of the mineral monazite, a thorium mineral that is very commonly associated with ilmenite in the beach-sand type of ore, and a mineral that is also an atomic energy raw material. To check the possibility of a substantial amount of monazite occurring in the deposits samples were sent to several government and commercial laboratories. Although the laboratory tests verified the presence of monazite in the samples, the amounts were too small to justify developing the deposits for their monazite content alone. It is possible, however, that should enough ilmenite ever be developed to justify working the deposits, a small amount of monazite might be recovered as a by-product in the milling operation.

ILMENITE IN THE UNITED STATES[1] [2] [3]

Uses

Although titanium is a metal that occurs in a variety of minerals, the two important minerals from an economic-

1 Bateman, A. M., Economic mineral deposits: p. 617, 1942.

2 Staffs of the Bureau of Mines and U. S. Geological Survey, Mineral resources of the United States: pp. 299-300, 1948.

3 U. S. Bureau of Mines, Mineral Market Surveys No. 1600, 1948.

al standpoint are ilmenite, an oxide of titanium and iron; and rutile, the dioxide of titanium. About 98 per cent of the ilmenite supply is used in manufacturing titanium dioxide white pigments for paint, paper, rubber, leather, ceramics, plastics, linoleum, printing ink, textiles, cosmetics and soap. Titanium white paints are noted for a high degree of covering power, brightness, whiteness and durability. Minor quantities of ilmenite are used in making ferrotitanium alloy and fluxes for the steel industry and in welding rod coatings.

PRODUCTION

Domestic production of ilmenite in 1947 was greater than ever before. Despite further expansion of titanium pigments plant capacity and new peak rates of pigment production a substantial part of the pigment demand could not be filled. The following table shows the trend in ilmenite production during the period 1941-1947.

Year	*Production in Short Tons*
1941	23,297
1942	77,208
1943	203,551
1944	278,610
1945	308,516
1946	282,447
1947	336,533

In 1947 the world's leading ilmenite producer was the National Lead Company's ilmenite mine at Tahawus, New York. The remainder of the domestic ilmenite production comes from the beach sand deposits near Jacksonville, Florida, from Finley, North Carolina, and from Roseland ilmenite-rutile deposits in Virginia.

Grade, Price and Treatment of Ores

There are two general types of ilmenite ores, (1) those in which the ilmenite occurs along with other minerals in solid rock, as in the New York and Virginia deposits, and (2) the beach-sand type of ore in which the ilmenite occurs as individual sand grains. Because of increased benefication costs, the ores of type 1 have to contain a much higher percentage of titanium dioxide than the type 2 ores. Thus, the ore at the Tahawus, New York operation will probably average 15 per cent TiO_2, while the Florida beach-sand ores may contain less than 1 per cent TiO_2 and still be workable.

Prices are generally quoted on ilmenite concentrates rather than on ilmenite ores, and the concentrates usually will contain about 50 to 60 per cent TiO_2. The nominal price of ilmenite concentrates (60 per cent TiO_2, f.o.b. Atlantic seaboard) was $10 per long ton in the 1930's, but demand boosted it to $18 in 1940 and $28 in 1941. In 1946 the price dropped to $19-$20 per long ton and it has varied from $17-$20 up to the end of 1947.

Ilmenite ore is first concentrated and the concentrates are melted in electric furnaces. The fused product is then leached with sulfuric acid to make titanium dioxide which undergoes further purification.

Reserves

Estimated reserves in known U. S. ilmenite deposits workable under the economic and technologic conditions such as those of 1944 total 17,478,000 short tons of ilmenite. Although 479,000 short tons of ilmenite were consumed in 1947, the U. S. production was only 336,061 short tons, the balance being supplied by imports chiefly, from India and Norway. Assuming no imports, as well as continued ability of the U. S. to produce at the 1947 rate, the estimated reserves would last approximately 52 years.

In addition to these currently exploitable reserves, there are large bodies of titaniferous magnetite (containing 2 to 22 per cent of TiO_2) in Colorado, Minnesota, Rhode Island and Wyoming. In most of these occurrences, however, the ilmenite is combined with magnetite in such small crystals or complex intergrowths that current milling processes will not yield a high-titanium product. An additional potential source of titanium is the red mud residue (7 to 12 per cent of TiO_2) from treating bauxite for alumina.