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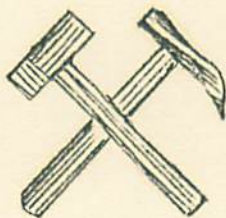
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MINERALS FOR NATIONAL DEFENSE-  
NORTH CAROLINA'S POSSIBLE CONTRIBUTION

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By  
T. G. Murdock

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MINERALS FOR NATIONAL DEFENSE -  
NORTH CAROLINA'S POSSIBLE CONTRIBUTION.

By T. G. Murdock<sup>#</sup>

Despite the varied mineral wealth of the United States, where the value of mineral products in 1920, a peak year, amounted to almost \$7,000,000,000, there are certain items which are listed as "strategic" and others as "critical." Strategic minerals are "those essential to national defense, for the supply of which in war dependence must be placed in whole, or in substantial part, on sources outside the continental limits of the United States; and for which strict conservation and distribution control measures will be necessary." Critical minerals are "those essential to national defense, the procurement problem of which in war would be less difficult than those of the strategic minerals either because they have a lesser degree of essentiality or are obtainable in more adequate quantities from domestic sources; and for which some degree of conservation and distribution control will be necessary."

The past decade has seen changes in these lists, dictated by rapidly changing world conditions, industrial developments, and especially extensive mechanization of the armed forces of the world, together with due appreciation of the importance of industrial preparedness as a part of national defense. The latest list of mineral products prepared by the Army and Navy Munitions Board is as follows:

Strategic: Antimony, chromium, industrial diamonds, manganese (ferro-grade), mercury, mica, nickel, quartz crystal, tin and tungsten.

Critical: Aluminum, asbestos, graphite, platinum, and vanadium.

Although in 1938 the value of mineral products of North Carolina only amounted to about \$15,000,000 and the State ranked 33rd, several of the strategic and critical minerals are found here and some deposits of these may be called upon to serve as an important source of supply, especially should present foreign sources be inaccessible. While practically all of both groups have been found within the borders of the State, some of them exist only in such small quantities or under such conditions that commercial production even under increased market prices would not be practical, in competition with more favorable conditions in other States.

Antimony: Antimony has been found in North Carolina, in the native state, from a small vein in Burke County. There is no commercial development and no deposits of commercial grade have been found.

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Chromium: Chromium is a most important industrial element. Its only important commercial mineral is chromite. Its chief use is metallurgical, as an alloy for steels, including stainless steel. Its use as a refractory has increased considerably since 1927. Chromium chemicals are used in leather tanning, pigment manufacture, and in electro-plating. There are domestic deposits but they are small and widely scattered and are commercial only when exceptionally high prices prevail. During 1918, shipments were made by 450 shippers, five of which were in North Carolina. Chromite occurs in small quantities in most of the peridotites and allied basic magnesium rocks in Western North Carolina and North Georgia. However, at only a few localities in these two states has it been found in sufficient quantities to justify investigation as to its mining possibilities. The deposits investigated are small and irregular in shape, but containing high grade chromite. The four most promising areas in North Carolina, where production was carried out in 1917-18 are: Dark Ridge Creek, Jackson County; Webster, Jackson County; Holcombe Branch, Buncombe County; and Mine Fork of Jacks Creek, Yancey County. Even the best deposits in the State are small; their nature makes it extremely difficult to estimate the tonnage except of that shown in surface outcrops. It is not practical under normal economic conditions to mine chromite from the small deposits in North Carolina, but in case of necessity, a limited amount of chromite can be quickly recovered from the several small deposits.

Industrial Diamonds: The chief use is truing abrasive wheels, but diamond drills, diamond dies, wheels and tools impregnated with diamonds or diamond dust, diamond-set tools, and many other uses are also important in industry. The modern automobile and airplane factory, and glass works in particular, would be badly crippled were it not for industrial diamonds. Over two-thirds of the world diamond output by weight is used in industry.

There are two kinds of abrasive or industrial diamonds, the black diamond called "carbonado" or carbon, and "bort". "Carbons" come mainly from the State of Bahia, Brazil, and exports in 1936 were 12,868 carats. These are the toughest and hardest of all diamonds. The "borts" include badly colored, flawed or broken fragments of diamonds, unsuitable for gems, and are obtained principally from South Africa.

In North Carolina, there have been thirteen authentic discoveries of the gem variety of diamond; in McDowell, Burke, Rutherford, Lincoln, Mecklenburg, and Franklin counties. These are considered as mineralogical rarities and subsequent prospecting has failed to reveal additional ones, or discoveries of a variety suitable for industrial use. While North Carolina has deposits of other abrasive materials such as garnet and corundum, these meet considerable competition from artificial abrasives and cannot replace the harder industrial diamonds.

Manganese: Manganese is the most important of all the strategic minerals, being one of which the greatest tonnages are required and one concerning which there is most difference of opinion as to domestic possibilities. The steel industry requires ore of a metallurgical grade for the manufacture of ferromanganese, the alloy used in making steel, where it serves as a deoxidizer and purifying agent, and as an alloying

element for special purpose steels, the consumption of manganese per ton of steel averaging approximately 14 pounds. Chemical uses of manganese include approximately 5 per cent of total consumption and include the manufacture of dry batteries, glass, enamel, paint and varnish dryers, pigments, dyes, and fertilizers.

Ores from which standard grade ferromanganese can be made should have a minimum of 40 per cent manganese, and preferably more. While the manganese-iron ratio in ferromanganese generally is about 5:1, the losses of manganese incurred in smelting require a ratio of about 8:1 in the ore. During the World War the reduction of the standard for ferromanganese made possible the use of crude ore with 35 per cent manganese and a manganese-iron ratio of 5:1, but under normal conditions an ore with less than 42 per cent manganese can hardly be classed as ferro-grade material. The chief accompanying impurities are silica and phosphorous; amounts of these over 8 per cent and 0.25 per cent, respectively, are considered undesirable and liable to a penalty for the excess.

Manganese has been found more or less sparingly in several areas in North Carolina but there are very few which give much promise of commercial operations. Up to 1917 only a few carloads of the ore had been shipped from the State. There was some production during 1917 and 1918, but this ceased entirely at the close of the war, activities being reported from Surry, Transylvania and Wilkes counties. At that time deposits in Clay and Cleveland counties were examined. During 1929 and 1930 considerable prospecting and development work was done on the deposits in Cherokee County southwest of Murphy, and in Transylvania County, near Pisgah Forest. Other deposits of possible commercial value occur eight miles east of Hayesville, Clay County; near Sparta, in Alleghany County; west of Lenoir, in Caldwell County; and on Shutin Creek, in Madison County. A deposit is also reported in the Western part of Cherokee County. During the period of 1929 to 1935, only two carloads were shipped from the State, to steel companies in Birmingham. Some months ago a deposit was opened up in McDowell County and analyses indicated it to be of metallurgical grade. A Company took over the deposit and several cars were shipped previous to the suspension of operations. Another deposit in Surry County gave promising assays and the property was being negotiated for.

Mercury: Mercury is a very necessary industrial metal. Its civil uses include the manufacture of high explosives detonators, drugs, mercury vapor lamps, paints, and felt; metallurgy of gold; disinfection of seeds; and, generation of power from mercury boilers. North Carolina has no commercial deposits and the records show no account of its having ever been found even in minute quantity.

Mica: Mica is a mineral used exclusively in its original form of compound. The tonnage of mica produced annually is small, but its special properties make it essential with electrical industries and important to many others. World production may be segregated into two main classifications: Block mica comprising slightly over one quarter of the total, and waste or scrap mica constituting the remainder. Of the latter, the United States produces approximately four-fifths or more than 20,000 tons.

As a result of this large production and the still larger deposits in this country, considerable misunderstanding has arisen. Therefore it should be clearly understood that no shortage is likely with waste and scrap mica and it is not classed as strategic. This particular kind of mica is usually ground, either wet or dry, for use in rubber, paint, wall paper, roofing material, electrical insulation and numerous other uses.

Mica in North Carolina antedates historical records. Stone implements unearthed in old deposits show that older even than Indian tradition, a race of men valued and mined for mica. Since 1903 North Carolina has supplied more than one-half of the total mica production of the United States. The mica belt covers twenty counties in Western North Carolina and extends northeast and southwest across the state, reaching an extreme width of 100 miles. The belt is sub-divided into three smaller belts: The Cowee-Black Mountain Belt; the Blue Ridge Belt; and the Piedmont Belt. The most important mica producing counties are Ashe, Avery, Buncombe, Burke, Catawba, Cleveland, Gaston, Haywood, Jackson, Lincoln, Macon, Stokes, Transylvania, Watauga, Wilkes, Yadkin and Yancey. A large number of mines have operated from time to time in all of the above named counties but in recent years most of the production of mica, both sheet and scrap, has come as a by-product from feldspar mines, and the largest production of scrap mica has been as a by-product from the Kaolin clay operations. During 1938 North Carolina's sheet mica production was valued at approximately \$88,000 and the scrap at \$162,000. The total tonnage was 61 per cent of the total for the entire country. Since then mica mining has shown increased activity and the United States Geological Survey has recently inaugurated a detailed investigation of the Spruce Pine District. Prices of domestic mica have advanced sharply, particularly on small sizes. A threatened shortage of "cigarette" mica for airplane spark plugs was averted by employing selected sheet. One authority has stated that "it has been definitely proven that the mica deposits in North Carolina are of sufficient size and extent, and these deposits can produce a grade of mica suitable for any purposes in case of war."

As already pointed out, there is no shortage of the variety of mica usually produced in this country, and particularly in the South. It is likely that an increased demand will be made upon domestic sources and producers should make available the best material they can manage. It should be emphasized that the grading and classifying of sheet mica is extremely complex and at least 100 different products are classed as unmanufactured mica. Not only do the sheets vary enormously in size but there are not less than six different qualities ranging from clear to black stained.

An interesting development is the investigation of alsifilm as a substitute for mica splittings. This is made from bentonite and it may compete with mica in the electrical field, if it can be produced commercially. Bentonite is a transported volcanic ash, altered after deposition. It swells to several times its original size when soaked in water and becomes a soft creamy mass. It is produced in at least four southern states and is available in others. It has been found in North Carolina but not in commercial quantities.

Nickel: Nickel ranks considerably below manganese and chromium, so far as world tonnage consumption is concerned, however it is more widely used industrially than either of them. Nickel's most important use is as an alloy in steel to give it hardness, toughness, and strength. It is also used as a copper, silver, and aluminum alloy. Strictly military uses are for armor plate, armor-piercing projectiles, gun barrels, recoil cylinders, and the military application of transport equipment.

Over 85 per cent of the world's supply is produced in the famous Sudbury, Ontario District, this supply being controlled by the International Nickel Company, whose stock appears to be held by American capital to the extent of about 50 per cent. New Caledonia, a French island possession in the Pacific, accounts for a large portion of the remaining 15 per cent produced in the world. Incidentally, a new nickel deposit being developed at Petsamo, Finland, figured prominently in the news last winter, being a chief objective of the Russian invaders.

Search for commercial deposits of nickel in the United States was intensified in 1938 and the deposits in North Carolina were investigated. These deposits were noted during the early corundum mining in North Carolina, but were considered as of little economic importance. Later, a mill and smelter were built at Webster, Jackson County, but operations were abandoned after a small amount of mining which consisted mainly of prospecting various parts of this ore body. The nickel of these deposits is in the form of various nickel silicates, associated with dunite dikes. Other deposits are found at Democrat, Buncombe County; near Pleasant Grove Church, Yancey County; near Leicester, Buncombe County; at Corundum Hill, Macon County; and at Little Buck Creek, Clay County. Several of these deposits are large but low grade.

Considerable work has been done recently at Webster, blocking out the ore and endeavoring to work out a suitable concentration method. The perfection of such treatment methods would certainly mean that the deposits could be worked and research work to date indicates that such may be possible and with the production of other products, such as magnesium sulphate, and olivine for use as a refractory.

Quartz Crystal: The quartz crystal which is a strategic mineral is that particular crystal form having piezo-electric characteristics. These crystals are used for radio frequency control, and must be optically clear, have growth line on three sides, and be free from flaws, cracks, ghosts, phantoms, veils, needles, bubbles, and twinning. There is no present domestic production of quartz crystal of a quality for use in radio equipment, but the United States does possess the machinery required to perform the highly technical task of cutting the radio crystals from the mother crystal. The discovery of quartz crystals having the above-mentioned properties has been reported from one or two localities in North Carolina, as mineralogical rarities.

Tin: Tin is industrially the most important of the non-ferrous group of strategic metals. Due to its unique ability to form thin, ductile, non-corrosive and closely adhering films on steel and other metals, its

anti-friction properties and its ability to act as a flux in binding one metal to another, its procurement presents a serious strategic mineral problem as the metal is indispensable for numerous purposes and domestic production during this century has been less than 0.1 per cent of national consumption.

The principal world producers of tin ores have been Malaya, Bolivia, Netherlands East Indies, with minor quantities from Siam, China, and Nigeria. The story of tin production in the United States is a short one, quickly told. Repeated attempts have been made to operate lode deposits in the Black Hills of South Dakota and the southern Appalachians, but the outputs have been small and were soon discontinued.

Because of its value it is possible to work very low grade tin ores, if they are in quantity. Tin ore was discovered near Kings Mountain, Cleveland County, in 1883. In 1886 systematic prospecting was begun and in 1888 a stamp mill was erected. The Gaston, Cleveland and Lincoln County deposits have been intermittently worked for tin, by attempting to hydraulic the material and remove the clay in a log washer. One authority has stated that if this process were reversed, and the white plastic clay produced for paper filler or white face-brick, the cassiterite (tin ore) nodules would have become a profitable by-product.

The pegmatites of the Kings Mountain district resemble those of the Black Hills and more than \$500,000 has been spent since 1887 in attempts to recover tin from several deposits. The largest shipments from a single deposit (Ross Mine) amount to about 130 tons of concentrate, and the total for the district since 1888 is probably less than 500 tons. Estimates of the probable grade of mineable material show a wide range depending largely on the assumed limits of the bodies. It has not been proven yet that bodies containing as much as several hundred thousand tons would yield more than 5 pounds of tin per ton. A detailed study of the district has recently been made by Geologists of the United States Geological Survey and their report is being awaited with much interest.

Tungsten: Tungsten, the heaviest of the base metals, has the highest melting point and the highest modulus of elasticity of all metals. It is used for high speed tool steel, lamp filaments, non-ferrous alloys, electrical contacts and electrodes, and for various purposes in the chemical industry. As in the case of other metals the most important military uses are the ordinary commercial applications that are involved in the production of military equipment of all kinds.

Tungsten minerals are rather widespread in the United States, but most of the attempts at commercial production are confined to 11 western States; Nevada, California and Colorado currently yield more than 90 per cent of the production. Tungsten, in the form of the ores wolframite and cuproscheelite has been reported from Cabarrus County, but no commercial deposits have been found.

Tungsten does not present as great a problem as do some other strategic minerals, not only because we produce enough to take care of

some of our needs, but molybdenum serves in some uses, including high speed tool steel. The United States, in 1938, produced 93 per cent of the world's supply of molybdenum and 78 per cent of the world total came from a single large mine at Climax, Colorado. Deposits of molybdenum are known to occur in Halifax County, North Carolina, and they may prove of commercial value.

Aluminum: Aluminum is not found in the native state. Its oxide, alumina, when in pure crystal form, is represented by corundum, sapphire and ruby, in the natural abrasive series. Hydrated alumina is bauxite, which grades into the bauxitic clays. Bauxite is known mainly as the ore from which aluminum is smelted, but it has a large use also in the manufacture of artificial abrasives and as a basis for certain chemical industries. Metallic aluminum possesses three outstanding physical characteristics that are responsible for its popularity: lightness, high strength as compared with its weight; resistance to atmospheric and many types of chemical corrosion; in addition it has a relatively high electrical conductivity, and hence can in many cases compete with copper as a conductor. In some applications, only one of these properties is of prime importance, while in others more, or even all, are necessary considerations.

North Carolina has no commercial deposits of bauxite although one reference has been found to an occurrence in northern Stanly County. However it does have one of the four large plants in the United States, at Badin, Stanly County, where ore is shipped for smelting, refining and further processing by modern processes using electric power produced locally. In 1938 the United States production of primary aluminum totaled 286,882,000 pounds, of which approximately 14 per cent were produced at Badin. The other plants are located at Alcoa, Tennessee; Massena, New York; and Niagara Falls, New York.

Asbestos: Asbestos may be termed indispensable to modern life. As the chief constituent of brake-band linings and clutch facings it is essential to automobile transport; in the form of gaskets and packings it is a necessary part of steam-driven machinery; as a heat insulator it plays an important role in both household and factory construction and equipment; and combined with cement it is employed in the manufacture of vast quantities of roofing and other building materials.

The United States is the largest asbestos-consuming country in the world but produces only a small fraction of its requirements of raw materials. In 1938 domestic sales amounted to 6 per cent of the quantity and 4 per cent of the value of domestic requirements.

Asbestos is usually white, gray or green and may be either fibrous amphibole or fibrous serpentine, known as chrysotile. To get one ton of asbestos fibre of various grades, it is necessary to mine and process at least fifteen tons of rock. It is graded into four grades, from the long-spinning fibre, used in weaving of textiles, to the broken bits used in cement, shingles, etc. At least fifty per cent of the entire manufactured product goes to the automobile trade.



In North Carolina there are many areas of peridotite rocks which have partly altered to serpentine. Associated with these peridotite and serpentine rocks are many deposits of chrysotile asbestos. Some of these are to be found at Glenville and Sapphire, Jackson County; near the mouth of Squirrel Creek and on the western slopes of Rich Mountain in Watauga County; there are also deposits in Ashe and Wilkes counties. The amphibole or anthophyllite varieties of asbestos are more important in North Carolina than the chrysotile variety. Between 1918 and 1923 there was some interest and prospecting in amphibole and anthophyllite asbestos in Macon, Jackson, Mitchell and Yancey counties. In 1919 North Carolina ranked third in the production of asbestos in the United States, the entire production coming from Cane River, Yancey County.

There has been a revival of interest in North Carolina asbestos and during the summer of 1939 approximately 60 deposits were optioned. Four or five of these entered into production, making shipments to experimental plants in New York State. If further investigation proves the deposits large enough, the erection of processing plants in the State would be desirable.

Graphite: Graphite is a crystalline form of carbon, chemically the same as diamond and charcoal. Because it was mistaken for lead, it was called plumbago and black lead, and graphite pencils are still almost universally called "lead pencils". Graphite is separated into two classes, natural and manufactured or artificial. The two are unlike in many physical properties and yet for certain purposes can be substituted for each other. Almost every country in the world has at one time or another, produced graphite, but a comparatively small number of countries has dominated the world industry, and among them, the two islands of Ceylon and Madagascar are most important.

Graphite is widespread in its occurrence in this country. It has been reported from nearly every state within the United States in which there are any metamorphic rocks. At one time or another it has been mined in at least 27 states. Alabama graphite operations were begun in 1888 but were of little consequence until 1913. During the World War there was marked activity in the region, with 30 plants in operation during 1918 and 10 others under construction. Since 1918 the industry has declined in spite of strenuous efforts to revive it. At present all the Alabama plants are closed and most of the mills in ruins.

Graphite is known to occur at many localities within the area of crystalline rocks in the central and western parts of North Carolina. A number of years ago an attempt was made to work a deposit near Graphitesville, McDowell County. A few tons were shipped in 1911 from near Franklin, Macon County. In 1916 there was some graphite mined in Catawba County and additional prospecting in Macon County. There was no report of graphite production during 1917, however a deposit of possible commercial value was discovered near Shelby in Cleveland County.

Platinum: At the time of the World War platinum was highly strategic in character, but since that time there have been marked changes in industrial uses, with increased domestic production, reduced demand in many directions, and at the same time an extensive development of substitutes, fostered by the high price of the metal. There has also been a radical change in the centers of production, Russian production giving place to increases from Canada and Columbia, which sources alone are more than capable of providing our requirements.

Platinum has been reported from several known localities in North Carolina but has never become of commercial importance here. The occurrence of grains of platinum among the sands of gold-washings of Rutherford and Burke counties was reported many years ago. It has also been found on Brown Mountain, in Burke County northwest of Morganton; and, near Burnsville, Yancey County. A belt of platinum-bearing rock is reported extending from Cedar Falls, N. C., to Danville, Virginia.

Vanadium: This metal is found in carnotite and eight other minerals, and is used in high speed tool steels, and as a deoxidizer in steels, bronzes, brasses, and bearing metals. It also occurs in iron ores, fire clays and granite. A minute quantity added to steel makes it harder, stronger and more malleable. In the form of metavanavate, vanadium is a valuable drier for paint oils. Vanadium driers act twice as quickly as manganese driers, and five times as rapidly as lead driers, and only slightly less rapidly than cobalt driers, and have no tendency to the formation of surface films or skins. No report of occurrence of vanadium in North Carolina has been found.

Summary of North Carolina's Position: On the basis of the detailed study of the strategic and critical minerals, the following summary has been prepared to tentatively classify each commodity with respect to the North Carolina deposits. While there may be a difference of opinion regarding some of them it is believed that this tabulation represents approximate values, under existing conditions, which may, of course, change slightly or radically with international developments or market prices:

COMMODITY	NOT KNOWN TO OCCUR	OCCURRENCE REPORTED, NO COMMERCIAL DEPOSITS KNOWN	RE-PORTED, NO COMMERCIAL DEPOSITS	SMALL COMMERCIAL PRODUCTION AT PRESENT	SEMI-COMMERCIAL PRODUCED COMMERCIAL- LY	EXTENSIVELY PRODUCED COMMERCIAL- LY	SOME COMMERCIAL PRODUCTION POSSIBLE	COMMERCIAL PRODUCTION DOUBTFUL
Antimony	-	X	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	X	-
Industrial diamonds	X	-	-	-	-	-	-	-
Manganese	-	-	-	X	-	-	-	-
Mercury	X	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	X	-
Quartz crystal	-	X (a)	-	-	-	-	-	-
Mica	-	-	-	-	X	-	-	-
Tin	-	-	-	-	-	-	-	X
Tungsten	-	X	-	-	-	-	-	-

CRITICAL	NOT KNOWN TO OCCUR	OCCURRENCE REPORTED, NO COM- MERCIAL DEPOSITS KNOWN	RE- NO COM- MERCIAL DEPOSITS AT PRESENT	SMALL SEMI- COMMERCIAL PRODUCTION AT PRESENT	EXTENSIVELY PRODUCED COMMERCIAL- LY	SOME COMMERCIAL PRODUCTION POSSIBLE	COMMERCIAL PRODUCTION DOUBTFUL
Aluminum	-	-	-	-	X (b)	-	-
Asbestos	-	-	-	X	-	-	-
Graphite	-	-	-	-	-	-	X
Platinum	-	X	-	-	-	-	-
Vanadium	X	-	-	-	-	-	-

- (a) Special variety as previously explained.  
 (b) Not mined in North Carolina - smelted, refined and processed.

A national defense program calls for considerable quantities of refractories and abrasives and North Carolina's production of these might be expected to share in any increased demand. Thus, in general, the State's deposits of such non-metallic minerals as olivine, kyanite, talc, pyrophyllite, feldspar, and vermiculite are important as a source of domestic industrial minerals which have a definite place in such a program for a variety of purposes. The field of usefulness of these is constantly expanding and emergency conditions will probably develop new uses for many of them. An interesting example of a new use for an industrial mineral, such a use being very important for its possible application to mechanized warfare, is the case of vermiculite, a biotite or phlogopite mica which has suffered a pronounced degree of alteration by natural hydrothermal agencies. This mineral in a fine state has an application as a lubricating agent in automobiles, both in the motor and in the transmission and rear end. It disperses readily in lubricating oil, like graphite, and provides a means of taking up uneven wear in automobile engines, increasing compression, and reducing oil consumption by filling the pores of metallic surfaces within the cylinders.

An abundance of cheap power, especially that near commercial mineral deposits, and particularly those involving electrometallurgical or electrochemical processes may be expected to prove an important factor in the development and production of North Carolina's minerals for normal industrial or emergency requirements.

On the whole, the entire subject is a most vital one to all, both as Americans and as North Carolinians. The mineral development of the State should not be considered primarily as a wartime effort, but rather as a logical development to provide raw materials for industry. Naturally emergency conditions would make some marginal deposits commercial which could hardly be worked in normal times, however, sound promotion with the application of modern scientific principles to the exploration, development, processing and marketing will make commercial some deposits which have not been commercial in the past.

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