Mineral Resources of the Sea

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Out of a total area of the earth, nearly 72% of the surface is covered by oceans having an average depth of about 15,000 ft. and a volume of about 300 million cubic miles. The sea abounds in life and mineral wealth, but it is also further enriched with the transport of rivers, glaciers, cosmic particles, atmospheric dust and even rainfall. It is interesting to note here that one cubic mile of sea water alone contains 38 lbs of gold, 1.4 tons of silver, 290 lbs of mercury, 47 tons of aluminium and a host of other metallic and nonmetallic sulphates, nitrates, phosphates, chlorides, bromides, iodides, carbonates etc. The mineral resources may be considered under (1) beach deposits, (2) shelf deposits and (3) deep sea deposits, for convenience and proper understanding.

Beach Deposits

Most of the beaches are good recreational areas. Any beach deposit is known as 'Sand' because of its grain size and its common mineral being quartz. In addition to quartz, minerals like felspar, mica and other dark coloured heavy minerals are also found. This composition varies from place to place depending upon the coastal rock types.

Thus the beach deposit is mostly a derivative of the coastal and inland rock types. In some regions like the Kerala and Ceylon coasts, there is a heavy concentration of minerals like Monazite, Ilmenite, Zircon etc. which are sources of atomic energy, hence mined and extracted. Ilmenite is a good source of Titanium and hence beach deposits rich in Ilmenite are extracted. Beaches of coral islands are made up of coral sand and similarly some others of shell sand, which are a source of lime, hence useful. Gold and Platinum occur as fine dust in the beach sands at Nome and West Kodiak, Alaska, in several old beaches found at different elevations and mined for over 60 years. Gold is also reported from beach deposits of Guatemala and southwest Oregon, but it is not known whether it is being mined today. Diamonds are pick-
ed from the beaches of southwest Africa at
the mouth of the Orange river and further
interior along the river also. It is con-
dered that diamonds may also occur in that
part of the shelf off the Orange river. These
diamonds are mined for several decades.
Now, Magnetite is mined from off Kyushu
island, Japan and in view of heavier con-
centrations on the shelf, mining is further
extended. Tin is extracted from the bea-
ch and shelf regions off Malaya. Besides,
good coarse quartz sand is also a source
of building material as that Calangute
Candolim beaches of Goa. As methods of
mining such deposits are improving and
sophisticated equipment is available, an
increase in mining activity can be foreseen.

**Shelf Deposits**

The continental shelf is that part
of the land which is a submerged exten-
tion into the sea and marks the area
between the low water line on the beach
to the sudden fall into great depth.
The width of the shelf varies from 2-3
miles (as along the Somali coast) to as much
as 100 miles (off Bombay/Cutch); however, the maximum being 750 miles
though the average for the world being 42
miles. This gently sloping region consists
of a few hundred to thousands of feet
thick sediment entirely derived from the
adjoining land mass.

Depending upon the characteristics
of environment in the different regions
of the shelf, several types of mineral
deposits like Phosphorite, Glauconite and
shell deposits are found in mineable
quantities; again, depending upon the
structural features of the subsurface sedi-
ment layers petroleum, salt domes and
sulphur are found. Further, depending
upon the source area of the adjoining
land, gold, diamonds, ilmenite, magnetite,
good sand and gravel, and even organic-
rich sediment which can be used as
manure can be extracted.

Huge reservoirs of petroleum are
discovered and tapped from the shelf
region of Gulf of Mexico, Black sea, Per-
sian Gulf and recently from the Gulf of
Cambia. Oil is also discovered in the
North sea. Subsurface sulphur is extracted
by Frasch process as in Freeport, Louisi-
ana. Salt dome is a cylindrical mass of
great vertical dimension thrusting upwards
through several hundred feet thick sedi-
ment, is itself a deposit of salt, but it is
invariably associated with petroleum. Huge
petroleum reservoirs are associated with
salt domes as found in Gulf of Mexico
and are being drilled today.

Phosphorite or phosphate rock
(major source of industrial phosphorus
and major component of fertilizer industry)
is found off Japan, Southern California,
South Africa and Argentina. Recently a
high phosphate content in the sediment
off Bombay-Saurashtra coast is also noti-
ced by the author.

Glauconite is a typical shelf de-
posit formed in the sea and contains 2-9%
of Potash, hence a source of potassium or
potassium compounds. It is found along
the coasts of California, off South Africa,
east coast of Australia, New Zealand,
Philippines, China, Japan and western
South America. It is a green mud usually
occurring in small tiny grains and often
filling cavities of foraminifera and shells
of other calcareous organisms and frequen-
tly associated with quartz, felspar and mica. It appears in the region of the shelf where elastic sediment is not deposited.

Calcereous oyster shell and its debris is dredged from the sea for use as lime and by the Dow Chemical Co. as a fixer for Magnesium. Sand and gravel is mined from San Francisco Bay for purposes as a building material.

Some closed basins or trough on the shelf contain a very high percentage of organic matter which according to some can be mined and used as a fertiliser. Such organic rich sediment basins are found off Santa Barbara, California (with 4% of organic matter), fjords of Norway, several smaller basins off southern California and the Caspian sea. Recently a similar deposit off Bombay having nearly 8% of organic matter is noticed by the author.

Gold is found in the deeper and farther shelf areas off Alaska and in the channels of south eastern Alaska & Oregon. Some of these areas represent the former beach levels when the sea level was lowered during the geological past. Some of the rivers which brought in places like gold and platinum had deposited at the lower reaches of the ocean e.g. Salmon river of west central Alaska. The Orange River of South Africa similarly brought in diamonds and some of the rivers in Thailand and Malaysia deposited tin which is mined today.

Subsurface magnetite deposits of Jussaro island, near Finland are being mined wherein mine shafts run at 300 m depth and 1200 m under the sea and into the deposit. Off-shore mining for iron ore is being carried out in Japan. Similarly coal found under the shelf in the sea is mined in Japan, England and Nova Scotia, Canada through tunnels driven from shore based shafts.

**Deep Sea Deposits**

The most characteristic of these are the manganese nodules and the 100% pure calcereous and siliceous oozes.

One of the greatest discoveries of the *Challenger* Expedition of 1873-76 is the report of widespread and abundant distribution of manganese rich nodules on the floor of all the three (Atlantic, Pacific and Indian) Oceans of the world. These nodules are found in a variety of forms invariably having a nucleus of foreign matter. The largest single nodule so far recovered weighed 850 kg.

These nodules, though primarily concretions of hydrous manganese dioxide also include small percentages of cobalt, nickel and copper. These nodules are formed under oxidising conditions. It is reported that the seafloor rock outcrops are coated with a layer of manganese dioxide, sometimes 10-15 cm in thickness. Thin concentric rings of manganese dioxide get deposited around a nucleus and slowly grows in size probably at a rate of 0.01 mm per 1000 years (e.g. Horizon nodule); but in some cases it was noticed they grow up several millimetres thick in a few tens of years (e.g. naval shell fragments with such coating noticed in the Atlantic).

There are two types of oozes which are the residual accumulation of hard parts of microscopic organisms such as Foraminifera, and Pteropods (of CaCO3),
and Diatoms (of SiO2). Thus, at deep sea regions, extending to several hundreds of kilometers, these deposits occur as blanket deposits of considerable thickness. These are very pure carbonate and silica deposits and if marine technology of mining is perfected they can be exploited. The calcareous deposits of the geological past after being uplifted are found exposed as part of land along the coast as cliffs and are known as chalk cliffs (e.g., chalk cliffs of Dover, England). In fact, ordinary chalk (blackboard chalk) when examined under the microscope, the tiny shells of these microorganisms are seen. Another type of sediment also occurs in the deep sea regions is known as the Muds. These clays or muds are of different colours hence differentiated as Red Mud, Green Mud or Blue Mud. Any future use of these muds, when known form very good and huge deposits for exploitation.