EXPLORATION AND EXTRACTION OF SAND AND GRAVEL RESOURCES IN THE POLISH EXCLUSIVE ECONOMICAL ZONE OF THE BALTIC SEA

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Abstract

In the Polish Exclusive Economic Zone the best recognised are gravel deposits. Three deposits; Slupsk Bank, Southern Middle Bank and Koszalin Bay with a total geologically documented resources of c. 279,810,00 m^3 are recognised. From the Slupsk Bank deposit c. 2,977,000 m^3 of gravel were dredged since 1985. The Koszalin Bay and Southern Middle Bank deposits are not exploited till now.
Sand resources are recognised in five deposits areas; four on offshore and one in the Puck Lagoon. Total geological documented resources in offshore deposits are 16,549,750 m^3. In the Puck Lagoon there is recognised of 18,500,000 m^3 of sand. Sand from offshore and Puck Lagoon deposits has been used for beach nourishment. Between 1990 and 2000 there was extracted 1,466,650 m^3 of sand from offshore deposits and 3,757,182 m^3 from Puck Lagoon. Because of increased coastal erosion much more surveys of sand deposits for beach nourishment will be needed in near future.

1. INTRODUCTION

The Polish EEZ covers an area of 30,533 km^2 and consists of a number of important bathymetric features. These include a number of basins such as Bornholm Basin (max. depth 95 m), Slupsk Furrow (max. depth 93m), Gotland Basin (max. depth 120 m), and Gdansk Basin (max. depth 107). With the exception of Slupsk Furrow, only parts of the basins occur within the Polish EEZ. The maximum depth given refer to those occurring within the Polish EEZ. In the south, there are shoals between the basins and the coast. These include the Odra Bank (min. depth 4.5 m), Slupsk Bank (min. depth 8 m), Stilo Bank (min. depth 18 m) and Southern Middle Bank (min. depth 14 m).

The main parent formation of the Southern Baltic marine clastic sediments are glacial and fluvioglacial deposits. Holocene marine sediments are residual or are the products of multipple redeposition of eroded Pleistocene deposits. Sediments on the southern Baltic bottom show strong differentiation especially with regard to grain size. Occurrence of each sediment type shows general regularities, and depends mainly on sea depth and distance from shore. Gravel, sandy gravel, gravelly sand, coarse, medium sands occur mainly in shallow water zone at a depths up to 30 m. Fine sands cover the seabed at a depths from 30 to 50-60 m in general, and also occur in shallower zone as an irregular patches between coarser sediments. Muddy sand, sandy mud occur at a edges of deep water basins, and mud cover central parts of the basins. Outcrops of Pleistocene and early Holocene deposits are not very common and are formed in some places by glacial till, interstadial sandy deposits, glacio-lacustrine clay and clays of early stages of the Baltic Sea development. The outcrops of till and clays on the thresholds separated the Basins are covered by a thin (< 0.2 m) layer of recent clayey sands. Ferromanganese concretions also occur with this sediments.

During the last 30 years geological prospecting and reconnaissance surveys carried out by the Branch of Marine Geology of the Polish Geological Institute has resulted in locating concentrations of various mineral products on the bottom of Polish part of the Baltic Sea. In some cases they are of potential economic significance (Geological. Atlas …, 1995).

2. SAND AND GRAVEL RESOURCES

2.1. Recognised resources

2.1.1. Gravel

Natural aggregate, i.e. gravel, sandy gravel and gravely sand, which form deposits on the seabed are the most thoroughly investigated mineral resources in the Southern Baltic. Up to the present day, three deposits; Slupsk Bank, Southern Middle Bank and Koszalin Bay have been documented (Fig.1).

Slupsk Bank is the elevation of the sea floor with the depths between 8 and 25 m, located c. 30 km north from middle part of Polish coast. The “Slupsk Bank” aggregate deposit lies at depths between 16 and 20 m. The deposit comprises eight fields of aggregate within sandy deposits in the middle and eastern part of the bank, or on a washed out surface of till – in the western part of the bank. The areas of the fields are between 0.8 and 10.5 km^2 and totally about 31.0 km^2. The thickness of the deposit layer is between 0.3 and 2.0 m, with an average of about 1.0m. The average content of grains with diameter below 2.0 mm (sand) is 64%. Geologically documented resources are 64.5 mln. tonnes.

Southern Middle Bank, similar like the Slupsk Bank is an elevation of the sea floor with the depths between 14 and 25 m. located north from Slupsk Furrow and c. 90 km form middle part of Polish coast. The “Southern Middle Bank” aggregate deposit lies at depths between 16 and 30 m. It is the farthest lying deposit in Polish exclusive economical zone, about 90 km from Leba and about 140 km from Gdansk. The aggregate occurs in the form of irregular patches of varying thickness, resting on sandy substratum, and in the south-western part also on till. Nine deposit fields have been documented with areas

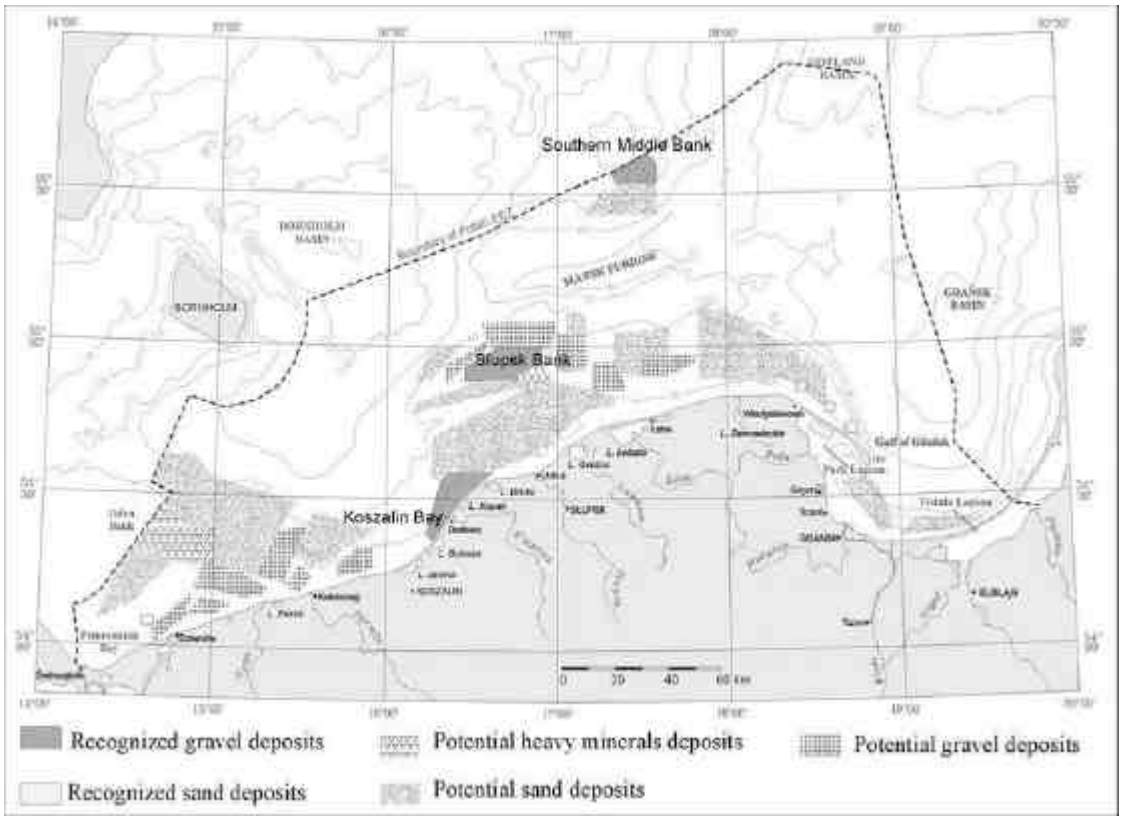

Fig. 1. Sand and gravel resoursces in Polish EEZ of the Baltic Sea.

ranging from 0.53 to 16.9 km^2 (totally about 26.0 km^2). The thickness of the deposit layer is between 0.3 to 5.0 m, with an average of 0.92 m. The average content of grains with diameter below 2.0 mm (sand) is 56.3 %. Geologically documented resources are 57.1 mln. tonnes.

The so called "Koszalin Bay" deposit area lies in nearshore, shallow zone north from Bukowo and Kopan Lakes. The "Koszalin Bay" aggregate deposit is in the shallow-water zone at depth 10.0 - 25.0 m. Seventeen deposits fields occur in the form of isolated patches lying on a sandy substratum, or in the south-western part, on till. The area of fields range between 0.3 to 3.6 km^2 (totally about 21.0 km^2). The thickness of the deposit layer is between 0.3 to 1.8 m, with an average of 0.9 m. The average content of grains with diameter below 2.0 mm (sand) is 60.1%. Geologically documented resources are 37.7 mln. tonnes.

Laboratory and technical investigations of the aggregates from the Southern Baltic deposits showed their very high quality. The aggregates are fully suitable for production of concrete including high strength concrete. The most important advantageous properties of the marine aggregate are their petrographic composition, with predominance of resistant crystalline rock fragments, very high crushing strength, and lack of alkali aggregate reactivity.

2.1.2. Sand resources for beach nourishment and land reclamation

Between 1991-1998 there were recognised five areas of sands for beach nourishment; four on the offshore bottom and one large area in the Puck Lagoon.

Three offshore medium sand deposits are located in north-western part of the Gulf of Gdansk, north to Hel Peninsula Its total resources are balanced to 14,849,750 m^3. The fourth area documented in 1998 is located in western part of Polish EEZ, 7 km north from Dziwnow The deposit field of area 0,96 km^2 contain c. 1,700,000 m^3 of medium sands for beach nourishment.

In the Puck Lagoon fine and medium sands deposits are recognised, which are suitable for beach nourishment and land reclamation. Sand deposits in Puck Lagoon with total resources of 18,500,000 m^3 are located about 0.6-2.5 km from the shoreline and at a water depth of 1-3 m.

2.2. Potential areas of gravel and sand accumulation

2.2.1. Gravel

Apart from the deposits described above with proven resources, there are also in the Polish EEZ other prospective regions with aggregate accumulations. The most prospective areas are on the north and north-western slope of Slupsk Bank and several smaller fields lying in the Pomeranian Bay, and in the shallow-water area between Dziwnów and Kolobrzeg. There are also a few prospective fields in the area to the north of Leba (Fig. 1).

2.2.2. Sand enriched with heavy minerals

Accumulations of sand enriched with heavy minerals are well investigated on the Odra Bank. As a rule, the enriched sand contains over 80% fine sand (0.25–0.063 mm) and is well- to very well sorted. The average thickness of the deposit layers is 0.55 m,

and the average heavy mineral content is 4.64% by weight. There are over 7.0 mln. tonnes of sand enriched with heavy minerals, in which there are about 0.5 mln. tonnes of heavy minerals; garnet, zircon, rutile, ilmenite, magnetite, monazite and others.

Two prospective areas with heavy minerals have also been found on the Slupsk Bank. Mean percentage of heavy minerals is 13.1 on the first field, and 3.1 on the second. According to preliminary assessments an average content of ilmenite is about 40 kg/t and 12 kg/t of sand, zircon, rutile and monazite — about 3.5 kg/t and 2.5 kg/t, and garnet — 3.0 kg/t and 9.5 kg/t, respectively.

2.2.3. Sands for beach nourishment and other purposes

Areas of medium and coarse grained sand accumulations for beach nourishment are expected in many places in the shallow-water zone (between 10 and 30 m water depth) (Fig. 1). The potential areas of fine sand for industrial applications are also known in many places. The best quality are the well sorted fine sands of the Odra Bank, which can be used as a raw material for the steel (moulding) and glass industries and as construction sands (Fig. 1).

3. GRAVEL AND SAND DREDGING

Marine aggregates have been exploiting from the "Slupsk Bank" deposit. About 2,380,000 m^3 of aggregate, were dredged between 1985-1989 using suction hopper dredgers. In 1990 exploitation ceased because of economic reasons. During the 90ties only 137,000 m^3 of gravel was extracted. Bigger dredging has been stared again in 2000, when 280,000 m^3 of gravel was extracted (Fig. 2). Exploitation from the "Southern Middle Bank" and "Koszalin Bay" deposits was carried out as a trial in the years 1987-1989. About 8,500 m^3 was dredged from each deposit.

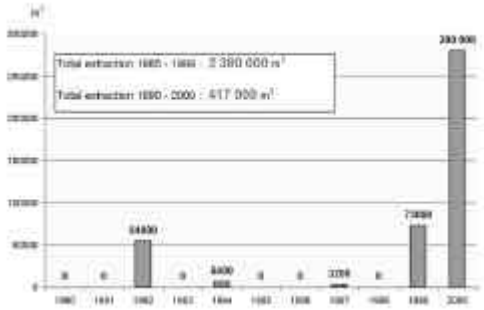

Fig. 2. Gravel extraction from Slupsk Bank.

Sand for coastal defence purposes has been dredged mainly in the vicinity of Hel Peninsula.

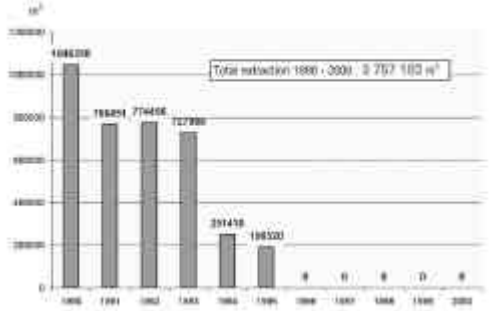

Fig. 3. Sand extraction from Puck Lagoon.

The Hel Peninsula is one of the most popular recreation regions on the Polish coast. The sand for beach nourishment is excavated by dredgers from the adjacent offshore bottom and also by a bypassing system from the Puck Lagoon. During 11 years (1990-2000) there was extracted 3,757,182 m^3 from deposits in the Puck Lagoon (Fig. 3) and was dredged 1,466,650 m^3 of sand from deposits on the offshore (Fig. 4).

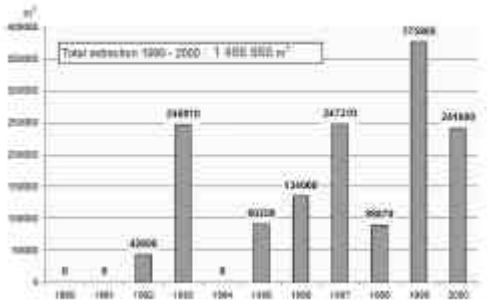

Fig. 4. Sand extraction from offshore deposits.

4. CONCLUSIONS

In the Polish Exclusive Economic Zone the best recognised are gravel deposits. Three deposits; Slupsk Bank, Southern Middle Bank and Koszalin Bay with a total geologically documented resources of c. 279,810,00 m^3 are recognised. Two dredging enterprises has the licences for gravel extraction from Slupsk Bank and Koszalin Bay deposits. From the Slupsk Bank deposit c. 2, 797,000 m^3 of gravel were dredged since 1985. The Koszalin Bay deposit was not exploited till now.

Sand resources are important because of increased coastal erosion. Till now sand resources are recognised in six deposit areas; four on the offshore and one in the Puck Lagoon Total geological documented resources in deposits on offshore are 16,549,750 m^3. In the Puck Lagoon there is recognised of 18,500,000 m^3 of sand. Sand from offshore and Puck Lagoon deposits has been used for beach nourishment. Between 1990 and 2000 there was extracted 1,466,650 m^3 of sand from offshore deposits and 3,757,182 m^3 was dredged from deposits in the Puck Lagoon.

Beach nourishment will be most important method of coastal defence, according to documents approved by Ministry of Infrastructure. Because of that, much more surveys of sand deposits will be needed. Also monitoring of environmental effects of dredging should be carried on in near future.

REFERENCES

Geological Atlas of the Southern Baltic. (ed. J. E. Mojski et al.). Panstwowy Instytut Geologiczny. Sopot - Warszawa 1995.