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Full Length Article

Spatial distribution and reserve estimation of sand and gravel deposits using geostatistical methods in west Basrah, southern Iraq

Safaa Al-Ali *, Sattar Al-Khafaji

Department of Geology, College of Science, University of Basrah, Basrah 61004, Iraq

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ABSTRACT

Sand and gravel are among the most common natural materials. They are generally used as a raw material in concrete, road construction, mixing with asphalt and filling material, among other uses. Sand and gravel deposits are widespread within the southern and central regions of Iraq. Among these deposits are the alluvial sand and gravel that form the upper part of the Dibdibba Formation in the Al-Rafiya, Al-Tuba, Chwaibda and Safwan blocks in west Basrah, southern Iraq. In this research, grain size distribution for channel samples collected from each block was determined. Thickness of overburden and industrial beds was measured and the stripping ratio (SR) was calculated. Geostatistical interpolation approaches including inverse distance weighting (IDW) and ordinary kriging (OK) were utilised to predict the spatial distribution of sand and gravel deposits and their reserves from borehole data. Data validation using the mean error (ME) and root-mean-square error (RMSE) were applied. The deposits can be characterised as gravelly sand (gS) in the Al-Tuba, Al-Rafiya and Chwaibda blocks, while it is a sandy gravel (sG) in the Safwan block. The overburden gypcrete beds varied between 1 and 3 m thick, while the industrial sand and gravel beds which appear as planar and sometimes lenticular deposits ranging between 3 and 8 m thick. The SR is generally low, considering the easily removed lightweight material of the overburden bed and the easily extractable fairly flat and near-surface friable sand and gravel deposits. Reserves are estimated as 376.63 Million m^3 and 385.97 Million m^3 using the IDW and OK approaches, respectively. Based on the least error values of ME and RMSE, we conclude that the OK method is the more accurate spatial interpolation approach for sand and gravel reserve estimation in all blocks compared to the IDW method.

Introduction

Sand and gravel are a combination of unconsolidated materials formed by decomposition and disintegration of different rock types by weathering processes and then transported by rivers, wind, glaciers and gravity to be deposited on the Earth's surface. They are usually found together and can comprise of grains and particles as small as clays (<0.002 mm) to boulders (256 mm; [1,2]. Sand and gravel deposits are mainly used as a raw material in concrete, road construction, mixing with asphalt and filling material, among other uses. Also, sand is particularly used in a diverse range of manufacturing industries such as glass, ceramics, refractories and abrasive materials, as well as in microprocessor chips and solar cells depending on their chemical composition, mineralogical characteristics and grain size [3,4].

Sand and gravel deposits are widespread within the southern and central parts of Iraq, mostly originating from Pleistocene alluvial fans and river terraces, such as those within the Nuba'i, Fatha alluvia fan, Al-Teeb, Chlat, Chwaibda and Safwan deposits [5]. Among these deposits are the alluvial sand and gravel in the Chwaibda and Safwan areas, as well as the Al-Rafiya and Al-Tuba areas in west Basrah, southern Iraq. These sand and gravel deposits have been invested by the Basrah governorate for several decades as a construction material in concrete and road bases. Since these deposits are non-renewable and facing an increase in demand, it is becoming increasing important to estimate the remaining unexploited reserves.

Reserve estimation is fundamental to determine the quantity and quality of a mineral deposit and to predict the variations in grade and thickness of a commodity [6,7]. It is also necessary for underground mine planning and design for both short- and long-term plans, as well as establishing the mineable portion of a resource, depletion rate, and mine or quarry life [8].

Several reliable methods have been applied to the estimation of mineral resources and reserves [9]. Nowadays, traditional estimation techniques such as polygonal, triangular and cross-sectional methods are

* Corresponding author.
E-mail address: safaa.alali@uobasrah.edu.iq (S. Al-Ali).

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