Subsidence in the Long Beach harbor area, California.

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SUBSIDENCE IN THE LONG BEACH HARBOR AREA, CALIFORNIA

JAMES GILLULY; U. S GRANT

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Article history

Abstract

Surveys and other observations in the area of Long Beach Harbor, California, indicate a general subsidence over a large area. Over the near-by plain to the north and east of the harbor, this subsidence averages a few tenths of a foot over a period of about 20 years. In this larger field of subsidence there is a localized area within which the depression of the surface amounts to several feet, reaching a maximum of more than 4 feet in the region of the Inner Harbor. This area of maximum subsidence, when contoured according to available level data, coincides remarkably with the productive area of the Wilmington oil field. It is also highly significant that the subsidence, as indicated by tide-gauge records, first became notable in 1937, shortly after the beginning of the development of the field.

The following possible causes of the subsidence have been considered:

Tectonic—earthquakes, horizontal and vertical movements in the earth's crust, faults, tilting.

Decline of pressure in water sands, lowering of the water table.

Increased loads due to structures and fill deposited on the surface.

Oil-field operations, including removal of oil from underground, decline of pressure in the oil reservoirs, with resulting increased load on them, and elastic shortening and plastic deformation expected therefrom.

The possible effect of each of these factors is discussed, together with data on the mechanical properties of the oil sands.

Conclusions reached are:

(1) A very small part of the subsidence—perhaps a few tenths of a foot—may possibly be due to tectonic movements but is not certainly so. It is equally likely to be due to decline of water pressure in aquifers underlying the whole region or, in part, to loss of reservoir pressure due to flow of water in the oil sands to neighboring oil fields.

(2) The excessive subsidence localized within the Wilmington oil field is primarily the result of oil-field operations. Reasons for excluding tectonic factors from responsibility are summarized. There is no correlation between the amount of oil production from a given part of the field and the amount of subsidence there, when areas as large as a "production block" (about half a square mile) are considered. There is some correlation between subsidence and production in areas of intensive exploitation, but this is believed to be indirect and dependent upon the influence of pressure decline on both processes. On the other hand, there is a very close agreement between the relative subsidence of the various parts of the field and the pressure decline, thickness of oil sand affected, and mechanical properties of the oil sands. This correlation is so close as to constitute conclusive evidence of a cause and effect relation between pressure decline and subsidence.

An accurate forecast of the amount of ultimate subsidence is impossible. In part it is dependent on the rate of production of oil and gas from the field, for the pressure drop in the reservoir sands may be expected, over a long time, to parallel this production rate. Although the current rate of subsidence is higher than the rate of pressure decline, this will probably eventually slacken, so that it may require 8 or 10 years for the subsidence of another 4 feet, and the ultimate subsidence to be expected if the production of the oil field proceeds to depletion is estimated at about 10 feet. This amount will not, however, be reached over the entire field, but is expected to be limited approximately to the present area of maximum subsidence. From this area the subsidence will diminish in all directions, so that, though the area affected by considerable sinking will eventually be somewhat larger than that now involved, the amount of subsidence will not be more than about two to three times that which has already taken place. In other words, the ultimate isobase of 1 foot subsidence may be expected to be near the present isobase of .50 foot subsidence. These estimates of ultimate subsidence are predicated upon continued exploitation of the oil field and will not be realized should production be substantially curtailed or stopped. On the other hand, should additional oil zones be discovered and produced, the above estimate would have to

be increased because of contraction of the additional oil sands.

First Page Preview

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Article activity alert

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