

The Jerusalem Institute for Israel Studies
The Center for Environmental Policy
Established by the Charles H. Revson Foundation

**Underground Mining of Aggregates
for the Building and Road-Paving Industry**

**Amir Eidelman, David Slutky, Amos Bein,
and Ran Haklai**

2007

The Center for Environmental Policy Studies Series no. 27

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The study was initiated and supported by the Ministry for Environmental Protection, the publication was made possible by funds granted by the Charles H. Revson Foundation.

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The Hay Elyachar House
20 Radak St., 92186 Jerusalem

<http://www.jiis.org.il>
E-mail: machon@jiis.org.il

Summary

It is customary to plan for the provision of raw materials for building and paving roads for a span of 40 or 50 years, and that is due to their economic importance and the necessity of ensuring their accessibility on a continuous and unobstructed basis. An optimal system of planning, working in the surroundings of a free market and a developing economy, aims to offer quantities of raw materials for building and road paving that are double or triple the expected demand for a given period of planning.

The national master plan for mining and quarrying sites (TAMA 14), approved in 2002 after an exhausting process that lasted over 30 years, was intended to provide for demand up until 2020. Recent surveys indicate that the accumulating reserve of stone for aggregates in Israel in 2006 is approximately 1,155 million tons, while the estimated accumulated demand for gravel for 2026 is between 750 and 900 million tons. Thus the balance of mining reserves in 20 years will be only 250-400 million tons. It is generally assumed that a decline in reserves below a minimum sufficient for a period of 10-15 years, that is, reserves of less than 500 million tons, will mark the beginning of a crisis that will be expressed by a rise in prices and pressure to find immediate alternatives.

This document discusses the feasibility of providing aggregates through underground mining out from open, existing quarries in the center of the country. This possibility is addressed in the context of the anticipated shortage of aggregates and the difficulty in planning additional quarries within the dense fabric of development planned in the center and north of the country. The provision of aggregates by underground mining is considered here as a possible alternative to the development of new quarries in the Negev or the import of aggregates from abroad, most likely from Jordan or Egypt.

This work focuses on the analysis of an underground mining alternative through:

- ◆ A general geological, engineering, and planning feasibility study and a detailed evaluation of a number of specific case studies;

- ◆ A general economic viability study, which concentrates on the evaluation of direct costs and definition of threshold values and framework for an overall appraisal approach within the context of the national economy perspective.

The cost of producing aggregates through underground mining is definitely higher than that of open-pit mining, but in terms of cost to the economy at large the additional, direct cost may balance out overall. Underground mining enables access to high quality stone-reserves while allowing for most of the surface to be open and free for other uses. Underground mining out of existing quarries is significantly cheaper and much less environmentally disruptive than setting up new mining sites. Underground mining out of existing quarries in the center of the country will allow for the use of local and regional stone-reserve potential, will limit transport distances, and will bring about a notable reduction in traffic load, as compared to the results of transporting aggregates quarried in the Negev.

Calculating the direct costs involved in the supply of aggregates from an underground mine in the center of the country as compared to the costs of the same in remote open-pit quarries in the Negev indicate that the discrepancy between both balance out at a difference in transportation distance of some 130-150 km. However, the question of economic viability steps far beyond the direct costs of production and transportation, and calls for a comprehensive examination of all the external parameters that relate to the subject. Among others, the calculation should address expenses to the economy as a whole, including load on roads, environmental issues such as nature preservation, noise, dust and air pollution, value of land, open space, and underground caverns, etc. Combing all the different parameters could indicate that introducing underground mining out from existing open-pit quarries is preferable to the conservative quarrying approach and should be encouraged as a national policy. The government has the tools and is capable of controlling the behavior of the corporations who produce the aggregates and encourage them to practically adopt underground mining methodologies.

Results obtained in the course of the present study, which involved the screening of the set-up at existing large quarries that together make over 90% of the overall aggregate production, indicate that many are suitable for extensive underground mining. A rough estimate suggests that the cumulative production of such mining

could add some 700-1000 million ton to the national aggregate reserve. Other sites which could be targeted for underground mining are the large quarries nourishing the concrete and quicklime industry and a number of deserted quarries.

The current document is intended to develop an awareness of the possibilities available in the development of underground mining, and to change the reigning ways of thinking about these matters. The presentation of this information is meant to trigger discussion in the course of which the present perspectives on the nation's aggregate industry will be reevaluated. The goal of this document is to lay a methodological basis for thorough evaluation of the possibilities for underground mining, in at least a portion of the existing quarries.