BRITISH COLUMBIA AGGREGATE INVENTORY PROJECT

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INTRODUCTION

In 1994, the Geological Survey Branch initiated a program focused on provincial aggregate resources. The goal of this new effort is to establish an inventory of both natural and crushed aggregate pits in British Columbia. A long-term aim of this program is to provide products which will assist planners and decision makers as well as industry producers, in their management and use of this finite resource. The success of future decisions regarding the availability, sustainability and possible sterilization of aggregate resources rests on the quality and availability of the existing information source (inventory database). Aggregate inventory information (*i.e.* number of pits, location, deposit size, volume, etc.) is presently incomplete and widely scattered. To improve the reliability of provincial evaluation and land-use decisions regarding aggregate resources, several short-term objectives were targeted in the aggregate program (Bobrowsky and Kilby, 1994).

The immediate objectives of this program can be summarized as:

- Establish a digital database inventory of all aggregate pits (active and abandoned, as well as public and private) in British Columbia, consisting of an identification label and location referenced to the geological database;
- Identify the geological landform and surficial deposit represented by each pit;
- Improve information transfer and data management (*e.g.*, through MINFILE), between key provincial ministries (Transportation and Highways, Forests) and external parties which are actively involved with aggregate resources;
- Sponsor an "aggregate potential mapping" (APM) workshop to develop acceptable scientific methods for evaluatingaggregate resources.

BACKGROUND

Excluding local studies completed by the Geological Survey of Canada some 25 to 40 years ago (*e.g.*, Armstrong, 1953; Learning, 1968), regional aggregate studies are rare and consist only of two published by the Ministry of Energy, Mines and Petroleum Resources (Hora and Basham, 1980; Hora, 1988). These two studies, which were completed a decade ago, are the most recent summaries of the entire industry in British Columbia. They provide a benchmark analysis of a significant part of the provincial aggregate industry and include reviews of aggregate-related legislation, principal participants, production, use and estimates of reserve life. However, the inventory information contained in the two reports is not current, which is an important factor for land-use decisions. Although several topical studies have appeared in the last few years (*e.g.*, Goff and Hicock, 1992; Levson, 1993) which address aggregate identification on a local scale, there is still a need for a province-wide study.

The need to establish and maintain an inventory of aggregate pits and deposits in the province is a reflection of the growing importance of the resource For example, Figure 1 shows the value of sand and gravel (in $ millions) for the years 1976 to 1992. During this period the production value of sand and gravel has steadily increased from a low of $48 million to a high of $151 million. The amount of sand and gravel produced over the same period shows no clear trend (Figure 2) and it is interesting that the amount produced in 1992 approximates the level produced in 1978, but the value has doubled. In the absence of an aggregate pit and deposit inventory, which would allow long-term monitoring of aggregate resources, a reliable quantitative estimate of rates of depletion and expected resource life is not possible.

DIGITAL DATABASES

INVENTORY

Information on aggregate resources in British Columbia resides with several provincial ministries (Environment, Lands and Parks; Transportation and Highways; Energy, Mines and Petroleum Resources, Forests), federal departments (Fisheries and Oceans; Transport Canada), local governments (municipalities and Regional Districts) as well as the aggregate producers. The nature of their interest ranges from revenue and planning to inspection/auditing and permitting/licensing. Most interested parties support some form of selective inventory adapted to particular needs. None of them manage a pan-provincial inventory, but all support the concept. This study seeks to address this data gap by establishing a basic inventory of aggregate data accessible to all interested parties. Such an inventory is required in areas where there is currently a demand for the resource or where a future demand is anticipated.

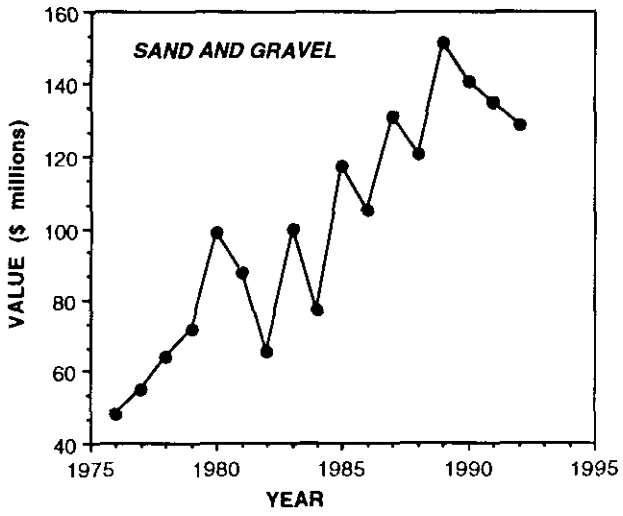

Figure 1. British Columbia statistics for sand and gravel value in $ millions for the period 1976 to 1992.

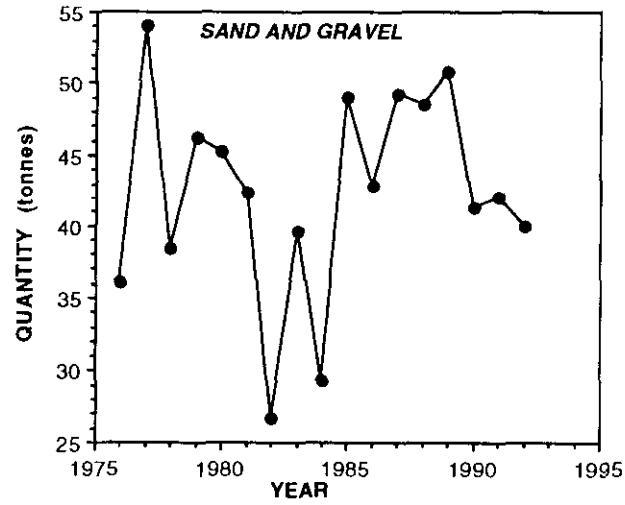

Figure 2. British Columbia statistics for sand and gravel production in tonnes for the period 1976 to 1992

In this discussion, two types of aggregate pits are recognized, public and private, and most of the information pertaining to the number and location of the pits is managed primarily by two ministries: Ministry of Energy, Mines and Petroleum Resources (MEMPR) and Ministry of Transportation and Highways (MoTH).

In British Columbia, all aggregate pits are designated as mines. Through the *Mines Act* and the Health, Safety and Reclamation Code for Mines, the Ministry of Energy, Mines and Petroleum Resources is concerned with the planning, management and regulation of mines on both Crown and private land. Because responsibilities include permitting, health, safety and reclamation, considerable effort is often expended on aggregate issues by the Land Management and Policy Branch of MEMPR. In the Land Management and Policy Branch, private aggregate pits are identified by a reclamation number and managed by Mining Inspection Districts. Moreover, the branch relies on completed Notices of Work forms to collect information on aggregate pits such as location, size and production estimates. However, Notices of Work indicate only expected production over the life of the permit and contain limited information on pit location and estimates of size. On submission of an application for a permit, information is abstracted from the Notices of Work and entered directly into digital format on a system called MIS (Mining Information System).

The Ministry of Transportation and Highways, through the Geotechnical and Materials Engineering Branch and Maintenance Branch, is responsible for ensuring that an adequate quantity and quality of gravel is available for construction, maintenance and rehabilitation of highways in the province (Ministry of Transportation and Highways, 1994). The MoTH gravel management program addresses its aggregate concerns by estimating gravel demand, establishing gravel supply strategies, finding new deposits, managing Ministry pits and purchasing new gravel. For the last several years, aggregate data have been mnaged by MoTH using three systems: ADIS (aggregate deposit information system), ARMS (aggregate resource management system) and RAAMS (regional aggregate account management system). The quality of the data captured is variable, as the location and status of many pits are unknown or incomplete. A new system, GMSS, which is a compilation of the above three systems, is expected to be adopted by MoTH following regional testing. This new database should eliminate errors and complete missing information fields. The Ministry uses its own aggregate identification system and manages data according to Highways Districts.

Our efforts to establish a digital inventory of pit frequency and location has begun with the use of reclamation files (which include Notices of Work) and the ADIS database as primary data sources. Individual pit identification and location are obtained, plotted on base maps and then digitized using QUIKMAP. The information is being compiled in a simple dBase format.

OTHER DATABASES

At present the project is using MELP digital 1:250 000 (NAD 82) topographic information as base-maps for data accumulation. These maps provide a general framework for viewing pit locations and are available for the entire province.

Using TRIM (Terrain Resource Information Management) data compiled at 1:20 000-scale as base maps could provide more accurate and detailed digital information. Specific groups of data layers are available at this scale and can be purchased individually. A pilot project explored the potential uses of these data for the map sheet 92G. The project relied on "designated areas" layers for all 1:20 000 maps in 92G which included layers for gravel pits, abandoned gravel pits and quarries. A complete base map of 92G was compiled with polygon forms for designated pit sites. Although the results of the pilot project are of interest, the data storage requirements of polygon information are high and preclude

continuation until all basic inventory data have been compiled.

Once completed, the basic inventory will consist of approximately 6000 pits and contain information on locations, geology and other related data. Our intention is to maintain a current accounting of the aggregate pits and to provide this information to interested parties as quickly and efficiently as possible. The problem of long-term data management and dissemination was considered and the use of MINFILE was recognized as a potential solution. The potential for merging inventory information with MINFILE was tested in our pilot project in 92G. The long-term use of MINFILE for the aggregate inventory is still under review.

AGGREGATE POTENTIAL MAPPING

Once established, the basic inventory of aggregate pits can be further expanded to include aggregate potential. As used here, the term 'aggregate potential mapping' denotes the identification and ranking of landforms suited for sand and gravel extraction, including probabilistic estimates of the quality and quantity contained based on a quantitative analysis of existing pit attributes and field observations. The concept of aggregate potential mapping is not new, especially the qualitative ranking of landforms, although the application of quantitative techniques has only recently been emphasized. For example, based on their work in Ontario, Gartner *et al.* (1981), provided a simple linear ranking of landforms in order of decreasing importance: outwash > esker > glaciofluvial delta > kame > raised beach > hummocky moraine > end moraine > glaciolacustrine delta > glaciomarine delta. In contrast, relying on their work in Alberta, Edwards *et al.* (1985) illustrated the inherent errors of qualitative aggregate potential analysis. Instead, they devised an economic potential procedure based on a deposit by deposit ranking using six geological factors: predominant material, deposit thickness, overburden thickness, potential for water table problems, material availability and deposit area (*e.g.* Fox *et al.*, 1987).

In British Columbia, Hora (1988) discussed aggregate potential by qualitatively categorizing deposits into three groups: known resources (A), probable resources (B) and possible resources (C). Where possible, additional subcategories were identified based on texture and sorting. His unpublished maps extended to a width of 5 kilometres along major transportation corridors throughout much of the province. Later, Levson (1993) qualitatively ranked deposits for a single map sheet into three categories: high potential (glaciofluvial and deltaic deposits), moderate potential (fluvial and alluvial deposits) and low potential (flood plain, muddy alluvial fan, talus and colluvial deposits).

Bliss (1993) has approached the need for aggregate potential mapping through quantitative modeling methods. He has generated descriptive statistics for volume and area on mixed landform assemblages based on sample sizes in excess of 200 cases. The method is derived from mineral deposit models of economic geologists.

We will examine the pros and cons of the above methods in relation to client needs.

SUMMARY

We anticipate that once completed, the inventory will be of use to industry producers, geologists, engineers, planners, managers and many others interested in the aggregate industry of British Columbia. Comprehensive planning and resource management strategies rely on a sound information source which, in this case, includes a knowledge of the distribution of active sand and gravel pits, as well as their geological setting. Success in such strategies may be further enhanced by the use of probabilistic estimates regarding resource potential (aggregate potential mapping). Access to digital inventory data should increase the number of users and client needs.

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