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Ground Water in the Han River Basin Republic of Korea

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The Han River Basin occupies 26,200 square kilometers, most of the northern fourth of the Republic of Korea, and extends north of the Demilitarized Zone into North Korea. The basin also includes the Imjin River Basin which was not included in this investigation because it is within the DMZ at its confluence with the Han River, and much of its area is military controlled or north of the DMZ.

The Korean Peninsula was uplifted and tilted westward from a hinge line in the Eastern Sea. The eastcoast was uplifted, the west coast submerged. The basin drains from close to the east coast westward to the Yellow Sea. The hinge line is along an underseas fault escarpment that parallels the coastline some 15 kilometers or more off shore. The Yellow Sea is a negative area that has been subsiding for possibly 65 million years under the weight of sediments depostied by the rivers of Korea and mainland China.

The rocks of the basin range in age from Precambrian to Recent. They include granite, schist, gneiss, meta-limestone and meta-sandstone, which make up about 80 percent of the basin, and sandstone, shale, coal, and limestone which make up about 20 percent of the basin. Along the streams and rivers are alluvial deposits of clay, silt, sand, gravel, and cobbles.

The rocks of the basin have been subjected to folding, faulting, fracturing, and intrusion which produced the openings that contain ground water. Carbonate rocks have been subjected to solution, resulting in large openings for for the storage of ground water, particularly in the Taebaeksan Region. The solution of limestone is occurring at the present time. During the investigation sinkholes formed just outside the basin south of Suanbo. Solution zones in the limestone follow favorable geologic structures and formations, and land subsidencecould take place in the basin. The solution zones also provide openings through which water may leak from reservoirs constructed in the limestone region of the eastern basin.

The drainage pattern of the basin resulted from the geologic structures, the uplift of the eastern peninsula, and the subsidence of the western peninsula. The basin drains from within 15 kilometers of the east coast toward the west, and the streams follow the prominent fault lines, major joint patterns, and lithologic contacts.

The volcanic rocks which formed in relatively recent geologic time in the rest of the peninsula are not found in the basin, but are in the Imjin River basin to the north, and the Naktong River basin to the south. Seismic activity on the Korean Peninsula seems to have been missing during historic time, but has occurred on the volcanic island of Cheju Do to the south.

Detailed geologic and hydrologic investigations should be made where and when water resources are needed, in order that comparative cost studies can be made to chose the least expensive source of water. The geologic studies will aid not only water resources studies, but also investigations for other mineral resources. Studies also are needed of the chemistry of both

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ground and surface waters in major and minor stream basins to aid in the search for and development of ground water and mineral deposits. Airborne infrared surveys would aid in the location of thermal water and some metal deposits.

In order to conserve funds, and at the same time build a corps of expert ground-water specialists and a complete data file, the work of ground water in vestigations would be better done in one government agency. As the work is heavily dependent on geologic studies as its base, a logical agency would be the Geological Survey of the Ministry of Science and Technology.

In 1969 ground-water use in the Han River Basin was estimated to have been about 330 million cubic meters, about 17 percent of the total water requirement. The estimated annual yield of ground water from the bedrock aquifers of the basin is at least 4,000 million cubic meters, and that of the alluvial sand and gravel deposits is at least 5,000 million cubic meters.

Ground water use in the Anyang Chon subbasin in the Seoul area was 61 million cubic meters during 1969, which is the equivalent of 29 percent of precipitation on that subbasin. However, much of the water pumped was from the alluvium of the flood plain of the Han River in Yong Dung Po. Because of the pumping, cones of depression had been created at Anyang town and Yong Dung Po, and both cones caused induced infiltration from the stream and the Han River. The induced stream water carried a large load of industrial wastes which caused contamination of the ground water. Its future usefulness is threatened by continued contamination. Some way other than indiscriminate disposal of industrial wastes in the streams must be found to prevent dtesroying the usefulness of the ground-water resources.

It would be possible to pump about 2,000 million cubic meters of ground water per year from the alluvium of the Han River flood plain in the lower basin from below Paldang Dam to the lower estuary below Seoul. During periods of extreme low flow this would cause serious depletion of the river.

The potential yield of ground water in the proposed Yoju irrigation area is about 300 to 400 million cubic meters per year. Further detailed investigations of the ground-water potential of that area should be made before a decision is made to irrigate with Han River water.

Ground water in storage in the bedrock and alluvium of the basin is estimated to be about 62,000 million cubic meters. Annual pumpage of about 3 percent of storage will meet the projected ground-water requirement of the year 2001 (2,361 million cubic meters). On the average ground water pumped from storage will be recharged annually during the summer rainy season.

Projected water requirements to the year 2001 and beyond can be met economically from ground-water resources, provided that personnel expert in ground-water investigation and development are trained, adequate well-construction equipment is acquired, electric power is made available, and down-the-hole pumps are manufactured locally.

Ground water can be developed from wells drilled in bedrock aquifers at rates of 4,000 cubic meters per day, at costs ranging from 2.391 to 8.686 won per cubic meter, based on amortization of investment and operating costs over a 30-year period. Depending on the bedrock aquifer, from 1 to 24 wells would be required. The same volume of water can be developed from the alluvium of major streams from 1 to 6 wells at costs ranging from 0.444 to 1.006 won per cubic meter.

Ground water from bed rock should be most useful in the future in providing safe water spuplies for towns, and for medium-use industries. It should be particularly useful in helping in the dispersion of industries to the eastern basin in the Taebaeksan Region and along the east coast where the existing population density is comparatively low.

Records of more than 130 wells drilled in bedrock in the Republic of Korea indicate that wells having depths of 50 to 120 meters will yield from 100 to more than 3,000 cubic meters per day. In the Han River Basin the limestone is potentially the highest yielding bedrock aquifer. Yields of 500 to 3,000 cubic meters per day can be expected. Wells drilled at favorable geologic structural locations in the granite and metamorphic rocks can be expected to yield from 250 to 600 cubic meters per day. Sandstone aquifers can be expected to yield from 200 to 1,000 cubic meters per day.

Well locations should be chosen on the basis of favorable geologic structures after investigations have been made. In order to meet projected water requirements, thousands of wells must be drilled. Investigations will improve the possibility of drilling the highest yielding wells and reduce the number of failures.

Gound water has been pumped from wells in bedrock for a number of years in several places in Korea. Chinhae City obtains more than 2,100 cubic meters per day from granite. The city has pumped form wells for several years. Individual drilled wells in the Pyongtaek area pump from 500 to 700 cubic meters per day from granite and gneiss. Drilled wells at many places in the basin and nearby Kyonggi Do have been yielding from 100 to 500 cubic meters per day for two years or more from schist, gneiss, granite, quartzite and limestone.

The thermal water resources of the basin are worth further development as an aid to the tourist industry. Three known areas of thermal water in the basin are near. Chunchon, Inchon, and Suanbo. Two other areas lie just east of the basin boundary near Sokcho and Yangyang. Investigations are warranted in other areas reported to have thermal water. Investigations could be hastened and improved by the use of infrared detecting equipment to find "warm spots" on the earth surface. Most commonly, infrared equipment is used from aircraft in order to survey large areas quickly.

The chemical quality of ground water in the basin is good for irrigation and municipal use and most industrial uses. High concentrations of carbon dioxide gas and iron occur locally. High dissolved chloride, nitrate, iron and manganese occur where ground water has been contaminated, most commonly by industrial wastes. High fluoride occurs only in the thermal waters. Most commonly, total dissolved solids are less than 300 mg/l. Water from limestone generally is hard, and that from granite contains as much as 30 mg/l silica. Sewage effluents has caused the pollution of many shallow wells in villages, and contributes to the high incidence of gastro intestinal diseases. High chloride and nitrate are common indicaters of fecal pollution.

Along the sea coast from Inchon to Kanghwa Do and along the lower Han River estuary, salty water occurs in some parts of the alluvium. Further testing will be needed before complete development of the ground water resources can be accomplished in those areas.

漢江流域의 地下水

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筆者들은 1966.3~1971.2까지 5個年間에 걸쳐 漢江流域의 地下水調査를 漢江流域 韓美 合同調査團의 一部事業으로서 實施 하였다. 漢江流域은 26,000km² 의 面積을 찾이하며 太白山地域이 流域內 東側 流域境界地에 걸쳐 있다.

1969 年度의 漢江流域內 地下水使用量은 約 3억 3천만m³ 으로서 需要量의 17%이었다. 流域內의 地下水可採水量을 岩層에서는 40억m³, 沖積層에서는 50억m³ 으로 推算할 수 있었으며, 流域內의 總地下水賦存量을 620억m³ 으로 推算하였다.

將來의 用水利用에 對해 豫測한바에 의하면 流域內 總用水需要의 25%까지는 地下水로 供給할 수 있는 것이다. 2001年까지에는 流域內의 이 地下水量은 年間 23.6억m³ 에 達할 것으로 推定된다.

岩層地下水에도 將次 期待할만 하며 中小都市의 上水道給水나 工業用水도 地下水에 依存될 수 있을 것으로 본다. 特히 東海岸과 太白山地域에 沿한 地帶는 그러하다고 본다.

國內 130個 岩層井戶를 對象으로한 資料分析에 依하면 50~120m深에 있어 100~3,000m³ 을 1日 採水可能하게된다. 또한 流域內 石灰岩地帶에서는 500~3,000m³ 이 期待 될것으로 보며, 結晶質岩이나 變成岩에 있어서는 250~600m³ 을 砂岩에서는 200~1,000m³ 을 採水可能할 것으로 본다.

地下水開發費用을 算定해 본 結果 1m³ 當費用이 岩層水는 2.4~8.7원 沖積層水는 0.5~1.0원 程度인데 地質과 地域 帶水性에 따라 若干의 差異는 있을 것이다. 流域內 下流部에 位置하고 永登浦를 包含하는 安養川流域에서의 地下水使用量은 1969年度에 6천 1백만m³ 이었는데, 工場地帶의 採水量 增加로 cone of depression의 現象이 뚜렷하고 工場廢水에 依한 汚染도 一部에서는 顯著 하였다.

將次 地下水需要量은 增加될 것이므로 地下水調査法과 位置選定要領 井戶設置에 對한 機械와 技術向上을 위한 硏究努力은 繼續되어야 할 것이다.