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Article 170

GROUND WATER IN THE ARICA AREA, CHILE

By WILLIAM W. DOYEL, Washington, D.C.

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Abstract.—The water supply for the city of Arica presently is obtained from a water-table aquifer in the lower Valle de Azapa. Water levels are declining owing to overdevelopment; an additional supply is needed to meet present demands. An artesian aquifer underlying the Pleistocene coastal terrace north of Arica apparently is the only other source of large supplies of usable water in the area.

The present (1962) water supply for Arica, the northernmost coastal city in Chile, is obtained from wells tapping a water-table aquifer in the lower Valle de Azapa [1] (fig. 170.1). In 1960 an estimated 400 liters per second was being withdrawn for the public supply and for irrigation in the part of the valley extending 40 kilometers inland from Arica (Kleiman and Torres, 1960). Water use both for the city and for irrigation has increased, and withdrawals have exceeded the capacity of the aquifer to yield water. The resulting rapid decline of the water table is forcing the city to search elsewhere for additional water supplies.

Rainfall west of the foothills (Pre-Cordillera) of the Cordillera de los Andes is negligible; only traces of rainfall have been recorded in Arica at intervals of several years. One perennial stream, the Río Lluta, flows through the area, but the water is too highly mineralized for other than limited agricultural or industrial use. The Río San José, which flows through the Valle de Azapa, is perennial in its upper reaches and intermittent in the lower part of the valley. The river discharges into the ocean only every 4 or 5 years when it is in flood stage, which may last a few days or a few weeks. A small amount of the floodwater is used for irrigation, but most of it is lost into the Pacific Ocean.

[1] Spanish terminology is used for geographic names; for example, Valle for valley, and Quebrada for valley containing dry or intermittent stream.

Water from the Río Lauca, on the Altiplano approximately 100 km east of Arica, has been diverted by means of canals and a tunnel into the Valle de Azapa and will help alleviate the water shortage in the area.

Arica lies at the northern end of the Cordillera de la Costa (Coast Range), at the mouth of the Río San José. Extending northward from Arica into Peru is La Concordia, a plain bounded on its eastern side by a north-south scarp and on its western side by the Pacific Ocean. The plain, which slopes gently westward to the ocean, widens northward and is approximately 8 km wide at the Peruvian border.

The scarp marks the westernmost extent of a thick section of conglomerate, sand, and pyroclastic deposits of late Tertiary and early Pleistocene age, the upper surface of which forms a westward-sloping plain extending seaward from the Pre-Cordillera. The Ríos San José and Lluta, which issue onto La Concordia from steep-walled valleys, as well as the stream that formed the Quebrada Gallinazos and now is intermittent and flows only at widely spaced intervals, have dissected the highland in the Chilean territory.

La Concordia was formed as a depositional terrace during the Pleistocene and is underlain by interbedded marine and continental sediments with a thickness of at least 200 meters. The surface is composed of at least three erosional terraces, each marking a stage in the recession of the sea. The Ríos Gallinazos (Quebrada Gallinazos) and San José have incised steep-walled channels into the surface of the plain, and the Río Lluta has cut a valley containing a series of terraces that can be correlated with successive stages in the lowering of the base level of the river. The Ríos Lluta and Gallinazos have built alluvial fans onto the most recent erosional terrace along the present shoreline, and the Río San José is building a delta.

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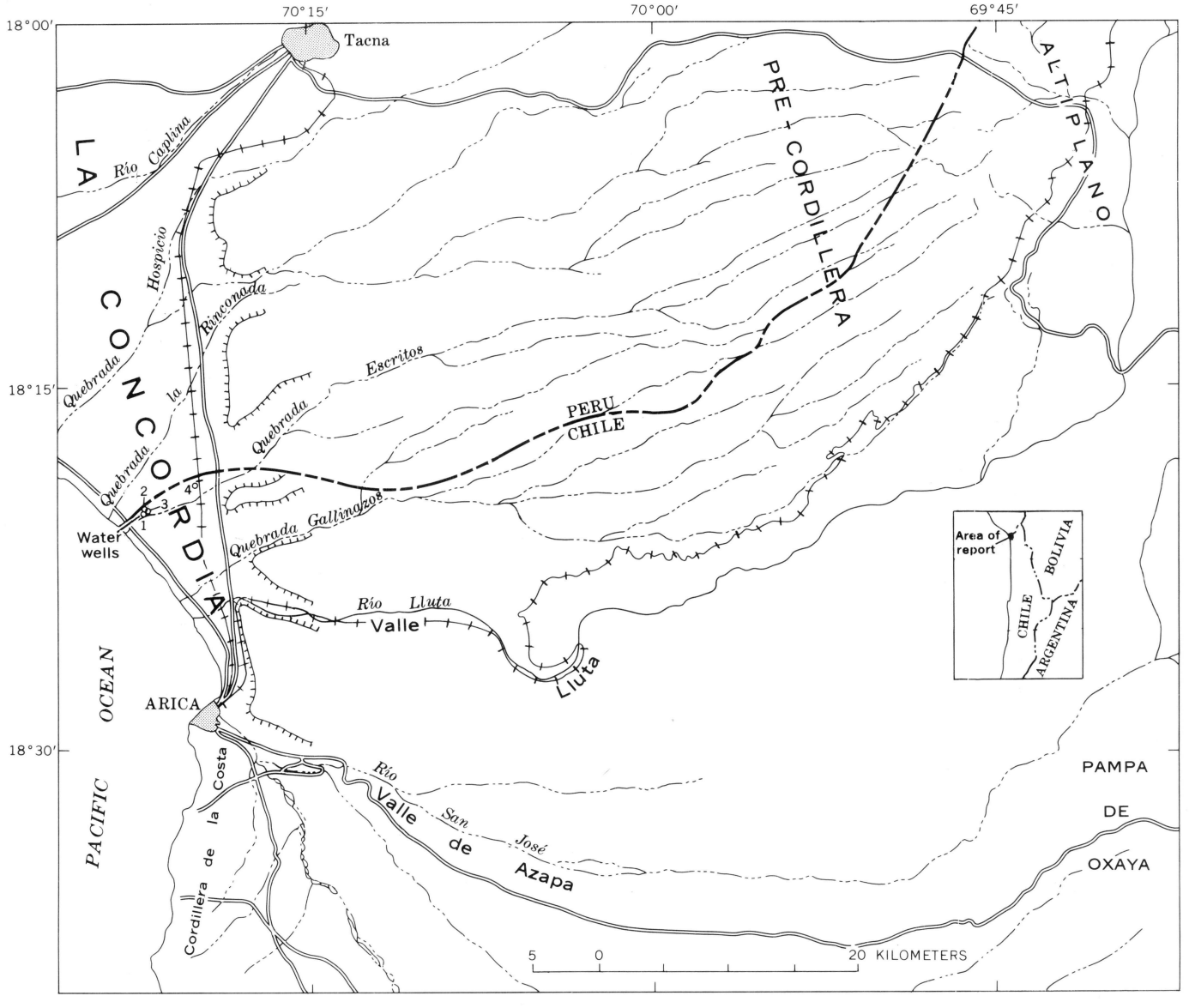

FIGURE 170.1.—Map of the Arica area, Chile.

Recent sediments are present in the form of colluvium, as alluvial deposits of the rivers, and as wind-blown sand covering much of the area. The face of the scarp that forms the eastern border of La Concordia and the surface of the high plain are covered in the Arica area with a concretelike layer of salt-cemented sandy or tuffaceous material.

The only possibilities for developing substantial additional ground-water supplies in the Arica area are in the Valle de Azapa, which is presently overdeveloped, the Valle Lluta, and on La Concordia; that is, from the Pleistocene and Recent sediments. Some of the older sediments probably contain and could transmit water, but lack of recharge and the effects of diastrophism preclude the possibility of developing substantial water supplies from the pre-Pleistocene sediments.

Ground water in the Valle de Azapa occurs in an unconfined aquifer in the alluvial deposits, which are less than 100 m thick. The aquifer has been exploited for several centuries, at least as far back as Inca times, but since the advent of drilled wells and large-capacity pumps it has been overdeveloped. As predicted by Taylor (1949), overdevelopment has resulted in a declining water table, which, in turn, has led to the abandonment of many hand-dug wells in the Arica area. In addition, all the springs have ceased to flow. Recharge to the aquifer comes from seepage and underflow from the upstream portion of the Río San José and also from floods and irrigation water. The water table slopes toward the Pacific Ocean, and fresh ground water probably is being discharged by evaporation and as seeps along the present shoreline near

Arica. Salt-water intrusion may be taking place but definitive data are not available.

Test wells drilled in the Valle Lluta have shown that the valley fill will yield little ground water.

About 10 years ago several successful water wells were drilled on La Concordia Peruana (the part of La Concordia in Peru), 7 km north of the Chile-Peru border. La Concordia Chilena (the part of La Concordia in Chile) is geographically and geologically similar to La Concordia Peruana, and 4 exploratory wells were drilled on it between the Quebrada Escritos and the border to determine whether the productive aquifer extended into Chile. All 4 wells struck artesian water that rose to within 15 m of the surface. The water occurs in sand and gravel strata between 75 and 130 m below the surface. Well 2 (fig. 170.1) was pumped at 150 liters per second (approximately 2,400 gallons/minute) for 120 hours, and as the maximum drawdown was 8.5 m, the specific capacity of the well was 17.6 liters per second per meter of drawdown. At the end of the test the water contained 835 milligrams per liter of total dissolved solids, 247 mg/l of chloride, 172 mg/l of sulfate, and 368 mg/l of total hardness.

The artesian head, the slope of the piezometric surface, and the water quality indicate that there is recharge to the artesian aquifer, although they give no information regarding the quantity. Test drilling has shown that there is no recharge reaching the aquifer from either the Valle Lluta or Valle de Azapa, and that recharge is probably coming from the northeast, from Peru. Ground water on La Concordia should not be developed without consideration of the possibility of intrusion of sea water, or possibly of inflow of salty marine connate water from unflushed parts of the aquifer as the artesian pressure declines.

A shallow water-table aquifer, penetrated in wells 1, 2, and 3, about 18 km north-northwest of Arica (fig. 170.1), probably is recharged from the infrequent rains in the area and could not support large-scale sustained withdrawals.

The artesian aquifer underlying La Concordia presents the best possibility for developing large additional water supplies in the Arica area. The diversion of water from the Río Lauca is increasing the ground water available in the Valle de Azapa, both by furnishing additional recharge and by replacing water supplies formerly withdrawn from the water-table aquifer. Artificial recharge by means of check dams and off-stream ponds also would increase the amount of recharge during periods of flood flow in the valley. Improvements in methods of irrigation could reduce the amount of water required per hectare, which would make additional water available in the Arica area. However, if the Arica area continues to develop, the Valle de Azapa, even with the Río Lauca diversions, cannot furnish sufficient water for irrigation, public supply, and industrial use.

The artesian aquifer beneath La Concordia has been supplying water for irrigation on La Concordia Peruana for 10 years without any significant lowering of water levels. This fact, together with the information now available (1962) as a result of the test-drilling program, indicates that the artesian aquifer beneath La Concordia Chilena could be exploited to supply additional water to the Arica area. Even if the water could not be used for irrigation on La Concordia, owing to the salinity of the soil, it could be used for public and industrial supplies, thus releasing ground water in the Valle de Azapa for irrigation.

Additional investigations, including drilling of test wells spaced throughout La Concordia Chilena, are being carried out by the Instituto de Investigaciones Geológicas de Chile and the Corporación de Fomento de la Producción de Chile to determine the ground-water potential of the artesian aquifer beneath La Concordia, as well as the maximum amount of water that can be withdrawn from the water-table aquifer in the Valle de Azapa without causing progressive water-level declines.

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