Section of Photography and Microscopy.

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Notes on the Water-Supply in Ancient Jerusalem.

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Information obtained in recent years indicates that Jerusalem was a strategic point in Palestine at an early period, but its importance as a metropolis was, as usual, of slow growth. For many centuries the city has been little more than a sacred memory. It received severe treatment at the hands of the Cæsars; the Emperor Hadrian, in the second century of the common era, destroyed it as far as he could and renamed the site. This attempt to efface the Holy City from the memory of man failed miserably, but the material evidences of its golden era were largely obliterated.

We know comparatively little of the ancient world, but one fact stands out in strong contrast to the conditions of medieval life, and even of many modern cities, namely, the care taken to secure a good water-supply. The highest honor for this sanitary measure is justly given to the city of Rome, but this was by no means the first. It is only of late years that the details of the water-supply of ancient Jerusalem have been unearthed. The following description is compiled from various recent sources.

Jerusalem is on high ground, and is surrounded by valleys. Its walls enclose a space of less size and population than some of the wards of Philadelphia. It is known that in some of the severe sieges, the inhabitants suffered most for want of food while the besieging armies suffered most for want of water. From this it is to be inferred that either springs existed in the city or that water was conveyed in concealed conduits. The latter view is now known to be correct; possibly the former is also.

It is believed by the authorities that the earliest efforts

at impounding natural waters so as to secure a constant supply for use at or near Jerusalem began in Solomon's time by the building of reservoirs in the Kedron Valley (east and southeast of the city) for the supply of water to the royal gardens. This reservoir, called by Josephus, Solomon's Pool, cannot now be found. Later an open channel

FIG. 1.—Map of Southern Jerusalem and adjacent districts. The tortuous aqueduct from the Virgin's Spring is seen on the right, in the Kedron Valley.

was cut in the rock forming the west slope of the Kedron Valley, by which the water was led to a point where it was easily available to the residents of the city. It has been suggested that the words of Isaiah, viii, 6, "the waters of Shiloh that go softly," are an allusion to the flow in this conduit which has but a slight grade. The original channel was identified in 1866. A more interesting and impos-

ing work was carried out some 300 years after Solomon's time by Hezekiah who, prior to the Assyrian invasion, impounded the water of a spring to the east of Jerusalem and brought it down to the east side of the city. This work is mentioned in both the accounts of Hezekiah's reign; thus, in II. Kings, xx, 20, we read: "Now the rest of the acts of Hezekiah and all his might, and how he made the pool and conduit and brought water into the city, are they not written in the book of the Chronicles of the kings of Judah?" Turning to II. Chronicles, xxxii, 30, we read that Hezekiah "stopped the upper spring of the waters of Gihon and brought them straight down on the west side of the City of David." Palestine archeologists regard Gihon as identical with a spring now just outside the city wall and known as the Fountain of the Virgin. The operation of Hezekiah involved the construction of a tunnel through rock in a tortuous course of over 1,000 feet, leading the water into two reservoirs near the southeast corner of the city. About twenty years ago an inscription in archaic Hebrew was found on the tunnel-wall near the lower end. The following is a translation of this inscription from a French version in *Rev. d. Etudes Juives*. I am indebted to Prof. Morris Jastrow for the reference to this translation, and also for an emendation of it, reading "blind alley" (*cul-de-sac*) instead of "accident" of the French text. "End of the boring. Here is what relates to the boring. While the borers worked their picks in opposing directions, and there were 3 cubits to break through, they heard each other's voices, for a blind alley was disclosed in the rock on the right and left, and on the day of completion the borers faced each other face to face. The waters ran from the pool-spring 1,200 cubits. The height of the rock above the borers' heads was 1 cubit."

The tortuous course appears intentional, for shafts were driven at two different points. It has been suggested that this course was rendered necessary to avoid rock-hewn tombs. The spring was intermittent, and has even been supposed to have a symbolic periodicity. It is an interesting example of how a legend may arise and be propagated,

that a traveler who visited Jerusalem in A.D. 333, and who is known in history as the Bordeaux pilgrim, states that the pool of Siloam was inside the walls of the city and that the waters did not flow on the Sabbath.

Excavations along the southern wall of Jerusalem have

FIG. 2.—Cross-section of aqueduct.

brought to light an aqueduct passing along the northern slope of the Hinnom Valley, penetrating the wall and passing towards the southeast corner of the city. This aqueduct is well built, being hewn out of a rock with rather steep incline. The upper and lower sides were extended by

FIG. 3.—Cross-section of enlarged portion of aqueduct.

walls, so that flat cover-stones might be used. The cross-section of the channel is rectangular, with a depression in the center line of the floor. The dimensions are about 3 feet high and $2\frac{1}{4}$ feet wide. Rock-hewn manholes were provided. At one point there is a chamber $5\frac{1}{2}$ feet long, 4 feet

wide, 9 feet high. F. J. Bliss, whose excellent work on the excavations at Jerusalem gives much information, thinks that this aqueduct is also the work of Solomon's time, but further information on this point is required.

In addition to these constructions, Bliss gives the lines of an aqueduct beginning to the west of Jerusalem, passing around by the south in the Hinnom Valley, and entering the city toward the east. This he terms the lower-water aqueduct, but gives no special information about it. We know from Josephus that Pontius Pilate "brought water into Jerusalem," but detailed information on this point is not available. His action provoked much dissatisfaction, possibly owing to exactions and oppressions practiced in carrying out the work. The name of this man has been anathema for so many centuries that we should not grudge him some honor for bringing in a new supply of water.

More extended excavations may be expected to yield still further interesting results as to the sanitary conditions of this ancient city.

ELECTROLYTIC REDUCTION OF LEAD.

On the subject of the electrolytic reduction of lead, Pedro G. Salom read a very interesting paper at the recent Philadelphia meeting of the American Electrochemical Society. He described the process invented by him and in use by the Electrical Lead Reduction Company at Niagara Falls. The ores that are reduced are sulphides of lead. They are used as cathodes in an acid electrolyte. The hydrogen ions combine with the sulphur of the ore and form hydrogen sulphide, which escapes as gas, while the lead sulphide is reduced to lead. This is the principle of the process. The apparatus used resembles in a general way a pile of dinner dishes of lead, piled one above the other. Each of these dishes represents a cell, the under side of a "dish" being the anode of the lower cell, the upper side the cathode of the upper cell. With forty-eight cells in series they use 130 volts and get 2 pounds of lead per horse-power hour.

The lead obtained in this process is in spongy form, and is then used for making other materials, like litharge. Owing to its spongy form, the lead is very readily transformed into litharge. Samples of spongy lead, compressed lead, litharge and other materials were shown. In future it is also intended to make accumulator plates.

The principal difficulty in the practical operation of the process was that the reduction was not complete, and that under apparently identical conditions the degree of reduction was not the same, especially as lumps of ore in the immediate neighborhood of the cathode plates were not reduced.