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Oman

The Falajs

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Flying over certain regions of Oman, you often see what look like rows of bomb craters stretching across the arid land below. In fact, these craters are the tops of access and ventilation shafts in the remarkable system of underground irrigation tunnels that are, in Oman, called *falaj* (plural, *aflaj)* and have different names elsewhere: *qanat* in Iran and other Muslim countries, and *foggara* in North Africa.

The *falaj* system is essentially a network of underground aqueducts through which water flows, by gravity, from springs or wells to villages and farms. Even today, it has been calculated, half the cultivated land in Iran is irrigated by these underground channels, and in rural Oman some 4,000 *aflaj* still provide most of the irrigation and domestic water supplies.

Unlike above-ground aqueducts, long sections of *aflaj* run through hand-dug tunnels - some of them 10 to 15 kilometers long (six to 10 miles) and close to 120 meters deep (400 feet). This feature is important in arid lands, where every drop of water is precious; it prevents water loss by evaporation.

Called *qanat* in classical Arabic, the *falaj* seems to have been developed in Persia and Armenia by at least 800 B. C. It was introduced to Oman and Iraq during Achaemenid times and spread from there into North Africa, Spain and, eventually, to the New World.

Construction of a *falaj* seems, at first, to be simple: from the farm or the village to a dependable source of water, almost always a perennial spring, you dig a gently sloping tunnel through which the water can flow. But that simplicity is deceptive; actual construction of a *falaj* is an undertaking relatively as sophisticated as the elevated Roman aqueducts that once criss-crossed Europe.

The first step is to find water and in Oman a special guild of "water diviners," the'Awamir tribe, have achieved fame for their ability to find hidden sources of water. Like American "dowsers," the 'Awamir use experience, observation and a certain amount of instinct. They study the soil, the slope of the land and, in particular, look for the presence, or absence, of certain types of plants, carefully noting the slant of their branches. They then sink a trial shaft. If they hit water, and think the flow likely to be constant, they organize construction of a *falaj*.

Since the force that moves the water through the channel is gravity, the floor of the channel must slope downward – but not too sharply. If the gradient is too steep, water pressure will erode the sides of the tunnel and cause the whole system to collapse; usually the gradient is 1:1,000.

Such expertise took centuries to develop. One treatise on how to dig these channels, and make the calculations and the instruments for surveying them, was written as early as the year 1000 by Abu Bakr Muhammad ibn al-Hasan al-Hasib al-Khariji, it described three different sorts of levels that can be used to gauge the slope accurately - one of them designed by himself.

Digging begins, not at the source where the flow of water would make digging impossible, but at the lower end. This means that the floor of the channel has to rise gently towards the source; to insure this, repeated measurements must be made.

Every 18 to 137 meters (20 to 150 yards), vertical shafts which provide access to the *falaj* must be dug, so that the excavated dirt can be removed. In medieval times, the workmen were paid on the basis of the weight of the excavated material. Since the shafts also provide air to the workmen who dig and clean the tunnels, they test the air with a lamp burning castor oil; if the lamp flickers and dies, they know that more air is needed.

The most dangerous part of the job - which in rocky soil is back-breaking - comes when the workers approach the water source, or break into water-bearing soil; at that point, water often pours into the channel's confined space, usually less than a meter wide (three feet) and not much higher.

Some *falaj* must be thoroughly cleaned about once every 30 years, and sometimes, when the water table drops because of depletion, a *falaj* has to be abandoned, or the well

deepened. Since this is expensive, the costs, typically, are shared by an entire community. In Oman a portion of the water is sometimes sold outside the community and the revenues used to finance upkeep.

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Some *aflaj* are quite efficient, producing a flow of 1,515 liters a minute (400 gallons), but most only give some 110 liters a minute (30 gallons), and in the hot summer months the flow, just when it is most needed, usually drops to a trickle. Conversely, since the *falaj* is always flowing, a great deal of water is wasted at other times.

One of the great legacies of the Arabs to Spain, this system of irrigation made agriculture and urban life possible in areas that would otherwise have been too arid. It is even said that the word "Madrid" is derived from a Spanish-Arabic word meaning *"falaj"*—by means of which the capital of the Spanish Empire derived its water. The system was carried by Andalusian settlers to South America, where *aflaj* identical to those in Oman are still to be seen in Chile and Mexico.

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