Some further thoughts on the geology of the Aammiq Wetland:

Chris Walley

This is a supplement to the 1996 report I wrote entitled *The Geology and Hydrogeology of the Aammiq wetlands Region.* It arises out of revisiting the area with Chris Leake in October 2003.

1) The structure of the region

I am still tolerably happy with the overall model and cross section given in the 1996 report. Nevertheless, a few elaborations are worth making.

- The abundant fracturing and faulting on the eastern side of Jebel Barouk should not hide the fact that the basic structure of the mountain is a single vast eroded NNE-SSW trending anticline. In terms of geological history, this anticline probably originated as a major fold in the Early Tertiary (say 60 to 45 million years ago) and was modified and sliced up by large-scale strike-slip faulting from about 15 million years ago. There are two implications of the basic anticlinal nature of Jebel Barouk for hydrogeology. The first is that the general trend of the bedding on the eastern side of the ridge is down into Bekaa, facilitating water flow. The second is that the Lower Cretaceous sediments that outcrop along the western edge of the marsh represent the eastern equivalents of the sediments seen overlying the Jurassic, approximately ten kilometres away to the west on the edge of the Chouf. Here though, on the Aammiq side of the mountain, these Lower Cretaceous sediments are heavily disrupted by faulting. A full sequence of Lower Cretaceous sediments is, no doubt, present at depth under the marsh.

- Although I still believe there are three main NNE-SSW trending fault zones on the eastern side of Barouk, I am now less confident that they represent the sum total of the faulting. Faults appear to be almost endemic through the western flank of the mountain and seem to defy categorising into just three zones.

- The hydrogeological significance of these faults is complex. In some cases, they are ‘open’ and presumably sites of heightened water transmission. In other cases, there is so much finely ground limestone (‘rock flour’) that the fault zones may act as almost impermeable barriers to water flow.

- There is strong evidence of at least some WNW-ESE trending faults – effectively at right angles to the main Yammouneh fault system – breaking up the outcrops of the Lower Cretaceous near Aammiq and creating what are effectively ‘piano-key’ like compartments.

2) The sediments of the valley floor

There is new evidence on the sediments that form the valley floor and underlie the marsh. This information comes from drillers, from well chips from depths of up to 70 plus metres and from augering sediments at shallow depths.

- All the evidence from drillers etc, confirms that the depths to the underlying Cretaceous and (possibly early Tertiary) rock sequences within the marsh are up to several hundred metres. There is no reason, as yet, to modify the cross section in the 1996 report.

- Despite the fact that the hinterland of the marsh is largely limestone, some clays do occur in these valley floor sediments. The origin of these clays are probably mainly from the Lower Cretaceous sandstones and clays and from the small amounts of clay present in the limestones. All the soft clayey units seen have as substantial carbonate content.

- Some fine quartz sand occurs in the sediments, probably from the erosion of the Lower Cretaceous sandstones that outcrop locally around the edges of the basin. Other quartz sands may be derived from the chert and silica associated with the limestones.

- Many of the soils are very dark suggesting the presence of unoxidised organic matter. In places, pale calcite shell fragments derived from the freshwater molluscs are present. Although some of the darker sediments contain fragments of reed and plant rootlets, no sediment seen so far corresponds to a true peat. If such peats do occur, they will probably be in the centre of the marshland.

- Harder units, which are difficult to auger and even to drill through, occur widely and the idea that the marsh is underlain by a sequence of soft sediments such as peats and clay needs to be refined.

    - Some harder units are the pale brown iron-rich calcareous concretions and sheets that widely occur within a few tens of centimetres from the surface. These hard zones formed in the marsh soils by the oxidation of the soluble form of iron to the insoluble form. They may also be linked to the formation of calcareous nodules in the near surface zone that commonly occurs in conditions of high evaporation. These zones of concretions may represent periods of emergence when local water levels are low. The iron in the concretions has probably originated from several sources. Some ions may have been washed in from the terra rossa soils that occur on the limestones and others may have come from the erosion of the often iron-rich Lower Cretaceous sediments. Further iron may have been supplied from the erosion of the basalt lavas that occur in the Anti-Lebanon.

- Other harder units are beds of limestone pebbles. These pebbles are often angular and were evidently derived from streams flowing into the wetland from the mountainsides depositing gravels. It can be assumed that these beds of gravel fine towards the centre of the lake. These granular beds of conglomerate may be major zones of water transport within the valley floor sediments.

- The limited work done so far suggests that the valley floor sediments are very varied. They were probably deposited in a continuously shifting mosaic of environments where calcareous muds were deposited on lake floors, peaty soils were formed by reed beds and streams carried in limestone gravels and sands. Periodic episodes of emergence gave rise to oxidised soil horizons. Because of the complexity of this mosaic, only some very general trends can be predicted. One of these is a decrease in the size of carbonate fragments vertically up the succession as the valley floor filled in. Another is a similar trend occurring laterally away from the flanking hillsides. Yet another trend is an increase in organic matter towards the valley centre.

- There are several implications from the fact that sediments in the valley floor are rich in clay, calcium carbonate, iron and organic matter. One of these is that thick and impermeable clay beds that might act as aquicludes may well be absent. A second is that such sediments are very vulnerable to chemical change. Under oxidising conditions, such as those that prevail when the marsh dries out, these sediments would tend to form soils dominated by near-surface layers of hard iron-pan or calcareous nodules. Such features, which are irreversible, do not produce good agricultural soils. The potential for such changes suggests that the agricultural potential produced by the drying out of the marsh would not last long.

Chris Walley 22 August 2008