

## Bats Below the Lake Bed: Layla Lakes and their Wonders Revisited.

In February 2008 Heiko Dirks and I happened to stumble over one of the greatest karstic wonders of Saudi Arabia, in fact it is a site that compares with nothing else world-wide: The dried out former Layla Lakes (see Kempe & Dirks, 2008; Kempe et al., 2009a,b; Kempe et al. 2010). In short, they are a series of large sinkholes, caved-in above the Upper Jurassic Ain Heeth Anhydrite formation (see our previous “adventure” in Ain Heeth in this website) that are clad with the most magnificent gypsum tufa. Words are not enough to describe the impression one has when strolling along the former bottom of the lakes looking up at the magnificent tufa that protrudes from the walls. The lakes have been drained in the late 1980ies and early 1990ies by lowering the general water table due to ground water mining from the underlying Arab aquifer. Interestingly we do not have a detailed record of this lowering but pictures in the internet show that the lakes used to be a hot spot of water sports like skiing and beach recreation (as far as beach fun goes for Saudi families). In fact a large hotel complex with nice bungalows and an open restaurant was planned and partly built at the SW side of the former lakes, now in ruins and stripped of any valuable material. Recently Nils Michelsen, another former student from Darmstadt (now doing his doctoral thesis about radon in Arabian groundwaters), located a paper by John Philby (1949). Sir Harry St. John Bridger Philby CIE (born 3 April 1885, Badulla, British Ceylon – died 30 September 1960, Beirut, Lebanon) was a British explorer, geographer, writer and intelligence officer and one of the early advisors to the Saud Family. He claims to have been the first European to ever visit the lakes. This was in 1918, not even 100 years ago. It took him 30 years to go there again. In 1948 he finally had the opportunity to take a closer look at the lakes then called Aflay Lakes. He describes surrounding the largest of them on foot, in between getting lost in the reeds before returning to his camp at the eastern shore (across the now defunct pumping station). At the time nobody even knew how deep the lakes are in reality and what strange features they were hiding below the surface. Philby however realized that they are artesian, i.e. derived from a deep seated aquifer. We do not know how clear the water was, but the copious lake-chalk (Seekreide) that precipitated from its water probably did not allow a clear view into the hidden depths of the lake. In fact, the chalk appears to be very thick around the lake, leading us to name it as a unique Quaternary formation: Layla Lake Formation. Already in 2008 we conceived the plan to drill the chalk to get a continuous sediment core that could be evaluated for its potential as a climate record. This plan became reality when in November 2010 a moveable drill-rig from Germany (Fig. 1) was available for two days that was used in a recharge research project at a different location. The recovered core is 10 m long and currently en route to our lab.



**Fig. 1: Drilling in the Layla Lake Formation in November 2010. Ruin of abandoned hotel in the background left. To the right the depression of the most southern lake (Photo H. Dirks).**

Thus was the state of the art when I arrived at the GIZ in Riyadh on January 20<sup>th</sup>, 2011. On Monday 24<sup>th</sup> I delivered my talk about lava caves and the hydrological potential of the Harrats at the Ministry of Water and Electricity, which was my assignment. Afterwards we were free to organize some field excursions. As already reported, the first one on the same Monday led Heiko and me down into Ain Heeth, just to discover that it is now filled with raw sewage from Riyadh.

For Friday and Saturday we decided to have an outing to Layla Lakes and to look at some shadows in the tufa wall that might hide cave entrances and that were not checked in 2008 due to lack of time. This time we were accompanied by Niklas Gassen and Tobias Fuest, both GIZ geologists and eager to do some climbing. Heiko, in spite of his recently becoming father of a second boy, arrived at my compound housing by about 8 AM with his 4WD. Niklas and Tobias followed with a second car. They had packed field beds and sleeping bags for an overnight stay as well as 70 m of rope and other climbing gear. I had brought some for myself plus a 10 m cable ladder. The day proved to be not only comfortably warm, but actually turned out to be the hottest (35°C) since a long time (it had heavily rained in Riyadh a few days before). We arrived in Layla at noon and turned east to As Sayh. This is the historic village that must have profited from the Layla Lakes because the qanats (subterranean water ducts) that issue from the northern ends of the lakes ended there. Heiko had visited it before and it is full of abandoned mud-brick houses, large square fortifications (Fig. 2) and dried out date plantations, a rather desolate picture. Recently, some of the plantations seem to be revived, possibly fed by water from deep wells instead of the traditional (and originally sustainable) usage of water conducted from the slowly upwelling lakes.



**Fig. 2: One of the old fortified mud-brick houses in the antique village of As Sayh (Photo H. Dirks).**

We follow a dirt track in parallel to some of the old qanats (Fig. 3) long clogged by drifting sand and more modern open channels, dry now also (Fig. 4). In between there are two pyramid-like platforms, one of which carries an old “MP” (British measuring point?). To the east the large towers of an even older settlement are seen (Fig. 5), that were already visited by Philby. He suggested that these are about 800 years old.



**Fig. 3: One of the ancient qanats, leading from the northern end of the Layla Lakes to As Sayh. View to the south.**



**Fig. 4: A more modern, open channel about 2 m deep. View to the north, toward As Sayh (modern housing in the back; modern pump station on the left).**



**Fig. 5: View east to two of the most prominent mud-brick towers of a medieval (?) settlement possibly predating the ancient As Sayh (as suggested by Philby) (telephoto shot).**

From the track we crossed some dunes to the larger of the northern of the former Layla lakes, named Wajjaj by Philby. This is a triple depression. We first inspect the southern sinkhole (Fig. 6), which ends at an overhanging wall that carries gypsum tufa formations. Hopes of an entrance to a cave are not met. However, hunters have discovered that the overhang is used by pigeons and have left a handful of cartridges (why don't they collect their garbage??). Towards the north the depression is circled by deep shrinkage crevices that cut meter-deep into the lake chalk. Actually one should not go down there since we leave footprints on the still pristine sediments (Fig. 7).

### Kempe's Qanat Question:

I advance the assumption that there is a mathematical function that links the distances between qanat pits and the depth of the tunnel by minimizing the work required to build the qanat. Or, in other words, the deeper the qanat is, the larger is the distance between building shafts.



**Fig. 6: Panorama view south into the southern sinkhole of Wajjaj (Philby). Dark hole in background is just an overhang, stabilized by gypsum tufa.**



**Fig. 7: The climb down into the southern Sinkhole of the former Lake Wajjaj.**

The central depression is not so deep and we proceed to visit the northern depression that is deeper and is encircled by vertical walls almost all around (Fig. 8).



**Fig. 8 Panorama view into the northern sinkhole of former Lake Wajjaj.**

It ends in a large natural bridge, about 15 m wide 5 m high and 10 m long (Fig. 9). It leads into the next, smaller sinkhole to the North, but we dare not to go through it in fear of further collapse. It is formed by lake chalk and stabilized by gypsum tufa on the outer faces. From current knowledge this appears to be the largest natural bridge in Saudi Arabia. This reminds me of my “discovery” (obviously the locals knew about it) of the largest natural bridge in Austria for which Hubert Trimmel had to find a new catalogue number (see Kempe, 1994). At the time I even “found” a complete underground castle hewn into a steep rock face nobody had reported before. You never know what you find when poking around!



**Fig. 9: View through the natural bridge between the former Lakes Wajjaj and Manjur (Philiby's terminology). Note Heiko standing on right hand foundation of arch.**

There is another looming “dark spot” in the sinkhole on the north wall that again proves to be only a small overhang. As a treat, a herd of black camels wanders along the rim of the sinkhole, yes, we are in Arabia and not in Austria... (Fig. 10).



**Fig. 10: A herd of black camels crossing the natural bridge between former Lake Wajjaj and Manjur (Telephoto shot).**

Next we have a look at the most dangerous sinkhole in the area that is only 15 m across and so deep, that the bottom is not really in view. Called Umm Al Habbab by Philby, it used to be protected by a fence, but busy, long-fingered hands have stolen the props since 2008, leaving the barbed wire behind, now forming dangerous snares on the ground, a true trap for tires, camels and humans. (Fig. 11).



Fig. 11: Panorama view North of circular sinkhole south of former Lake Wajjaj the bottom of which is largely out of sight (estimated >30m deep). Barbed wire lying around it because the fence posts have been “socialized”. The black and yellow posts in the center ground demarked the former “beach area” of Lake Wajjaj that opened behind it.

Next we look at the sinkhole Mufawiq (Philby) which is characterized by large blocks of sunken wall that form gigantic steps on its SE wall (Fig. 12). The old channel connecting it to Wajjay and further north to the qanats is well visible in the field and on Google Earth.



**Fig. 12: Sinkhole Mafawiq, view to the northeast. Note the step-like breakdown structure on the right wall.**

We advance further south and arrive at the former pumping station that was built to take water directly from the largest of the Layla Lakes (Umm al Jabal; Philby). An awesome metal platform still protrudes from the side over the former lake, now providing a wide view into the largest of the sinkholes, about 1 km long and 400 m wide (Fig. 13).



**Fig. 13: Panorama view south into the largest of the sinkholes, the former Umm al Jabal Lake. Note protruding platform on the left that served to hold the pipes in place to pump the water directly from the lake. In the far back the silhouette of the abandoned hotel and its water tower can be seen.**

Philby had suggested to build such a station and to connect the lake to the northern ones in order to extract more water. That in the meantime the entire water table was reduced by deep wells nobody seems to have taken into account. Who knows if the investment ever had its return. Now the old pipes are seen at the floor of the sinkhole, waiting to be buried by drifting sand (Fig. 14) together with some later garbage. Luckily the input of waste has not increased and the holes have not advanced to serve as dumping holes, a fear I had in the past three years.



**Fig. 14: The old pipes of the pumping station rest and rust on the floor of the former lake.**

Next, Heiko guides the vehicles along the eastern rim of the lake on a rugged trail, avoiding both the rim of the sinkhole, barbed wire snakes on the ground and steep slopes. At some places we have to cross the meter-deep crevices caused by the shrinking of the drying-out

sediments. We arrive at the southern-most sinkhole, near the site of where the core was taken. Here is an 8 m high profile, exposing the upper section of the lake chalk that we want to sample (Fig. 15). Now Niklas takes over, directs one of the cars to above the profile and hooks up rope and ladder. He volunteers to climb down to sample the profile every 0.5 m. Elegantly, he tosses up the filled cups to be caught and labeled by Heiko and me (Fig. 16). Tobias climbs down the path of the other side of the sinkhole and takes pictures of the operation. Finally Heiko also rappels down the profile (Fig. 17) to take a closer look and to have some fun. The operation is watched by a man standing about 50 m away, wearing trousers. Where does he come from, why doesn't he say hello? There are no houses nearby. For the local people we probably look like aliens, wearing helmets, belts, knee-protectors and hanging on a rope at the wall of the lake, doing obviously nonsensical things like digging in the sediments or throwing sample cups...



**Fig. 15: Setting up the work at the profile, Niklas sampling (Photo T. Fuest).**



Fig. 16: The 8 m high profile of lake chalk, exposed on the SW Side of the sinkhole below the hotel (Photo T. Fuest).



**Fig. 17: Heiko is rappelling down the profile in the back the gypsum tufa walls of Sinkhole 2.**

At the end we have 15 samples. Some contain shells of the two species of gastropods (Figs. 18 and 19) that lived in the lake that can potentially be dated by  $^{14}\text{C}$ . Dr. H.-J. Niederhöfer (Staatliches Museum Stuttgart) was so kind to determine which species they are from the specimens collected in 2008: The turret-shaped one is the cosmopolite and salinity-tolerant *Melanoides tuberculata* (Müller, 1774) (red-rimmed melania) and the other species is *Radix natalensis* (Kraus, 1848) (alias *Lymnaea arabica*). In dating these shells, we hope to get an estimate how quickly the chalk is deposited. The profile can also be compared with the core data.



Fig. 18 (left) and Fig. 19 (right) *Radix natalensis* and *Melanoides tuberculata* from the Layla Lake sediments.

Before we leave, we have a look at one of the unexplored pits, that is at least 15 m deep (Fig. 20), too deep for now, since we only have 10 m of ladder and Niklas is not yet acquainted with SRT to take the risk for him to go down and then work his way back up again. But there may be some real cave down there, because, as we peer into the abyss, a bat is circling in it, checking on the light outside.



**Fig. 21: Unexplored pit at the side of Sinkhole 2.**

By now it is sunset time. We drive around to the old hotel and look for a place to camp. Heiko boldly drives into the former restaurant (Fig. 22) and we settle for a place looking at the former beach and across the southern sinkhole. For the fire we collect some small trees that grew on the desiccating sediment and wood that was left by the builders of the hotel. Since we skipped lunch, we now feel our stomachs groaning and decide to drive into Layla. We find a nice and clean restaurant where we get chicken shawarma and mixed grill and lots of icy fruit juices. Thus refurbished we drive back to the hotel curving around some sand dunes in the dark and park the cars where the visitors were supposed to have a good view of the lakes. In front of the hotel the field beds are set up and soon the fire spreads its warm light around (Fig. 23). Marvelously Tobias produces four smoked trout from a bundle of newspaper as a special treat— smoked by himself! Some Holsten alcohol-free beer is available as well and we feel like we were in our old Boy-Scout days (Fig. 24).



**Fig. 22: Parking inside the old restaurant, a convenient garage in the middle of nowhere.**



**Fig. 23: Camp outside the former hotel restaurant, facing the former beach.**



**Fig. 24: The fire gives light, warmth and creates memories of old times. It also serves to digest our garbage and some of the filthy stuff lying around.**

The night is not very cold and Orion, Sirius, Canopus and the Lion pass by as the night advances.

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