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Lake Bogoria, Kenya: Hot and warm springs, geysers and Holocene stromatolites

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A R T I C L E I N F O

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A B S T R A C T

I carried out the first regional geological survey of the central Gregory Rift Valley in Kenya in 1958–60, and review here the numerous subsequent specialised studies focused on the unique endoreic Lake Bogoria (formerly Hannington), studies which embraced the sedimentology of the Holocene sediments around the lake shores, the hot-spring and geyser activities and the coring of the sediments beneath the lake. I focus on the occurrences of stromatolites in a hydrothermal environment, both in two closely spaced late Holocene (~4500 yr BP) generations at the lake margin, associated with algae and cyanobacteria, which represent a final more humid climatic phase after the several interglacial more humid phases (also represented by stromatolite occurrences in other rift valley lakes); and also at present being formed, at the edge of the now highly saline lake, in the very hot springs in association with thermophilic bacteria and with silica. I briefly mention the older occurrences in Lake Magadi to the south, which are quite different; and form three generations; and also present-day occurrences of stromatolites in a flood-plain environment, unlike the present-day environment at Lake Bogoria. Other stromatolite occurrences are mentioned, around Lake Turkana and the former lake in the Suguta River valley to the north. I suggest that the hot waterfall at Kapedo, at the head of the Suguta River, and the central island of Ol Kokwe (with hot springs, amidst the fresh water Lake Baringo) could well be investigated for stromatolite occurrences. Lake Bogoria, an empty wilderness occupied only by flamingos when I mapped it, is now more accessible and provides a unique open-air laboratory for such researches, but like all the Rift Valley lakes, is unique, *sui generis*. Results of detailed investigations of the type reviewed here, can only be applied to other occurrences of stromatolites elsewhere in the rift system or beyond the rift system with reservation.

Contents

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1. Introduction

In 1958, employed then as a government geologist, I was assigned to map two quarter degree sheets, an area of approximately 2400 miles^2 (3650 km^2) in the Gregory Rift Valley, straddling the equator. After mapping the basins of Lake Nakuru and Elmenteita, and the caldera volcano of Menengai (McCall, 1967), I mapped 'Lake Hannington, now 'Bogoria'. Access was then difficult: the road from Nakuru and Solai terminated above a 2000 ft (600 m) cliff above the south end of the lake (Fig. 1), and the only other access was from a road between the lake and Lake Baringo to the north of the lake. This was at that time a quite unmapped part of the Rift Valley and the lake, situated in a half graben below the Laikipia Escarpment, was highly saline. A few flamingos visited it daily from the hordes on Lake Nakuru to the south, but the fringes of the Lake were devoid of human settlement. Prominent was the geyser (Fig. 2), erupting every 10 min or so on the extreme southwest shore at Kwaibeipei (Kweipopei): and clouds of steam arose from the 200 or so lakeside hot springs (Fig. 3).

The volcanic geology of the Lake area was quite simple: the west side of the half graben formed a slope down from the Kabarnet Ridge in the centre of the Rift Valley, exposing the extensively 'grid-faulted' Plio-Pleistocene Hannington trachyphonolite flows. On the east side of the Lake, older Miocene phonolites and basalts formed the towering, stepped Laikipia Escarpment, the east wall of the Rift Valley, and there was only locally a veneer of the younger trachyphonolites fronting these older rocks. However, both sides of the lake revealed complex arrays of normal faults, and the trachyphonolites to the west were 'grid-faulted'.

I was fully occupied unravelling the complicated volcanic stratigraphy, with only 12 months in the field allotted to the entire task, and the geothermal occurrences and associated sediments, including travertine deposits, took second place. I did, however, include a reasonable summary of these occurrences (McCall, 1967, p. 73–86).

I recovered a sample of the travertine from the Emsos springs on the southern escarpment, and noticed stromatolite structures in it, though these did not attract much attention, for this was some years before the Shark Bay, Western Australia, discoveries focused attention on modern stromatolites and their forming organisms.

Since then, a wealth of literature has been produced, and Lake Bogoria (as it is now named) (Figs. 4 and 5) has become an open-air laboratory for the study of Holocene climatic fluctuations, hot-spring activity and stromatolite production in an endoreic lake rift valley setting, a quite different environment to the marine environment of the Shark Bay setting or West Australian inland lake settings, admirably reviewed by McNamara (2009). With a strong interest in this topic—I covered Geysers and Hot Springs in the Elsevier Encyclopedia of Geology (McCall, 2007)—I review below the literature produced about Lake Bogoria and its stromatolites and hot springs since my pioneer mapping, with some extension to stromatolite occurrences in other Rift Valley lakes.

Fig. 1. The escarpment of trachyte lavas at the south end of Lake Bogoria, with the lake in the foreground (photo by G.J.H. McCall).

Fig. 2. Geyser spouting off at Kweipopei, in a ten minute cycle (photo by G.J.H. McCall).

2. Conclusions from the 1958–60 regional survey

The conclusions reached (McCall, 1967, pp. 73–86) were derived from the author's own observations and measurements and also those by government hydrogeologists and hydrologists. The lake is not a sump in the rift valley floor, but water from it moves north underground, towards Lake Baringo, and slightly saline groundwater, mixed with natural gas, returns to the surface in the Loboi hot springs just north of the lake, in a fault zone (McCall, 1967, p. 81). At the southern end of the lake, there is no continuity between lake water and underground water bodies.

The activity of the Kwaibeipai (Kwaipopei) geyser, the most spectacular, was variable according to the level of the lake, and, on one visit, when the lake was at its highest level, was seen to be totally inactive. Normally it erupted every 10 min or so, whereas the smaller Loburu geyser had a 3 minute periodicity (McCall, 1967, p. 81), and the line of hot springs situated there at a fault intersection changed activity simultaneously. There was a travertine terrace sloping down to the lake from them, coloured pink and orange, and with colloidal encrustations. Boiling pots at Kiboriit (McCall, 1967, Plate III), again along a fault line, had a similar development of travertine.

Fig. 3. Hot spouting springs at Kweipopei: the geyser nearby is quiescent at the time (photo by G.J.H. McCall).