Recent Changes in Geyser Activity at Loburu, Lake Bogoria, Kenya Rift Valley

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Abstract

Major changes in hydrothermal activity have accompanied frequent fluctuations in the level of Lake Bogoria, Kenya, during the past decade. Even minor changes in the levels of the lake surface and the shallow lake-marginal groundwater can have an impact on geyser behavior. Some geysers that were active during 2001 and 2005 had become weak hot springs or steam vents by August 2006 following a fall in lake level, whereas activity at other springs had increased. At Loburu delta on the western shore of the lake, the geyser activity increased, and one of the geysers, KL30, erupted on a regular 45-minute cycle to 5 m height. When active, KL30 is probably the highest natural geyser in Africa. In contrast, a major rise in lake level in 2007 suppressed activity at many of the geysers, including KL30.

Introduction

Lake Bogoria in the central Kenya Rift Valley has the highest reported concentration of geysers in Africa. At least 18 geysers are known to have erupted during the past 30 years (see Figures 2–4 in Renaut and Owen [2005] for geyser locations). All the geysers lie near the shoreline of this saline lake, which fluctuates frequently in level and salinity in response to short (years) and longer-term (decades and longer) climatic changes. Renaut and Owen (2005) described the main geyser activity and its known history. Between August 2005 and August 2006, the lake level fell by about 30 cm, which led to major changes in the activity at several of the shoreline geysers. Eruptions ceased at some vents, whereas discharge at other geysers increased significantly. One of the geysers active during summer 2006, KL30, erupted regularly to a height of about 5 m, making it the highest reported geyser in Africa. In contrast, heavy rains during early 2007 led to a rapid rise in lake level. During August 2007, the lake surface was an estimated 15–20 cm higher than its August 2005 level. This led to the submergence of many hot spring vents and a decline in activity at KL30 and several other geysers. The main purpose of this paper is to record the changes in activity at KL30 and other geysers during the past three years. The close link between geyser behavior and lake level fluctuations at Lake Bogoria (Renaut and Owen, 2005) is confirmed.

Environmental setting

Lake Bogoria, with a salinity approximately twice that of seawater, lies just north of the equator in a narrow half-graben basin in the central Kenya Rift Valley (Fig. 1A). The lake catchment is composed mainly of densely faulted volcanic rocks of Miocene to Pleistocene age. Geothermal activity is abundant. Almost 200 hot springs discharge Na-HCO_3-CO_3 waters into the lake from three main spring groups located along the shoreline at Loburu, Chemurkeu, and Ng'wasis-Koibobei-Losaramat, respectively (Fig. 1B). The climate is semi-arid with about 700–900 mm annual rainfall, which is much less than the potential evaporation of more than 2,500 mm per year. With no surface outlet, the lake is hydrologically closed, and its surface level undergoes frequent and rapid changes mainly in response to variations in rainfall. Present lake level is approximately 990 m above sea-level and the local boiling point is approximately 97.5°C. Details of the general setting are given in Renaut and Tiercelin (1993, 1994), Harper et al. (2003), and Renaut and Owen (2005).

The new activity described here is present at Loburu, a small delta on the midwestern lake shore. About 60 hot springs discharge at Loburu from vents clustered along two north-south trending fault-lines (Fig. 1C). The number of onshore springs varies with

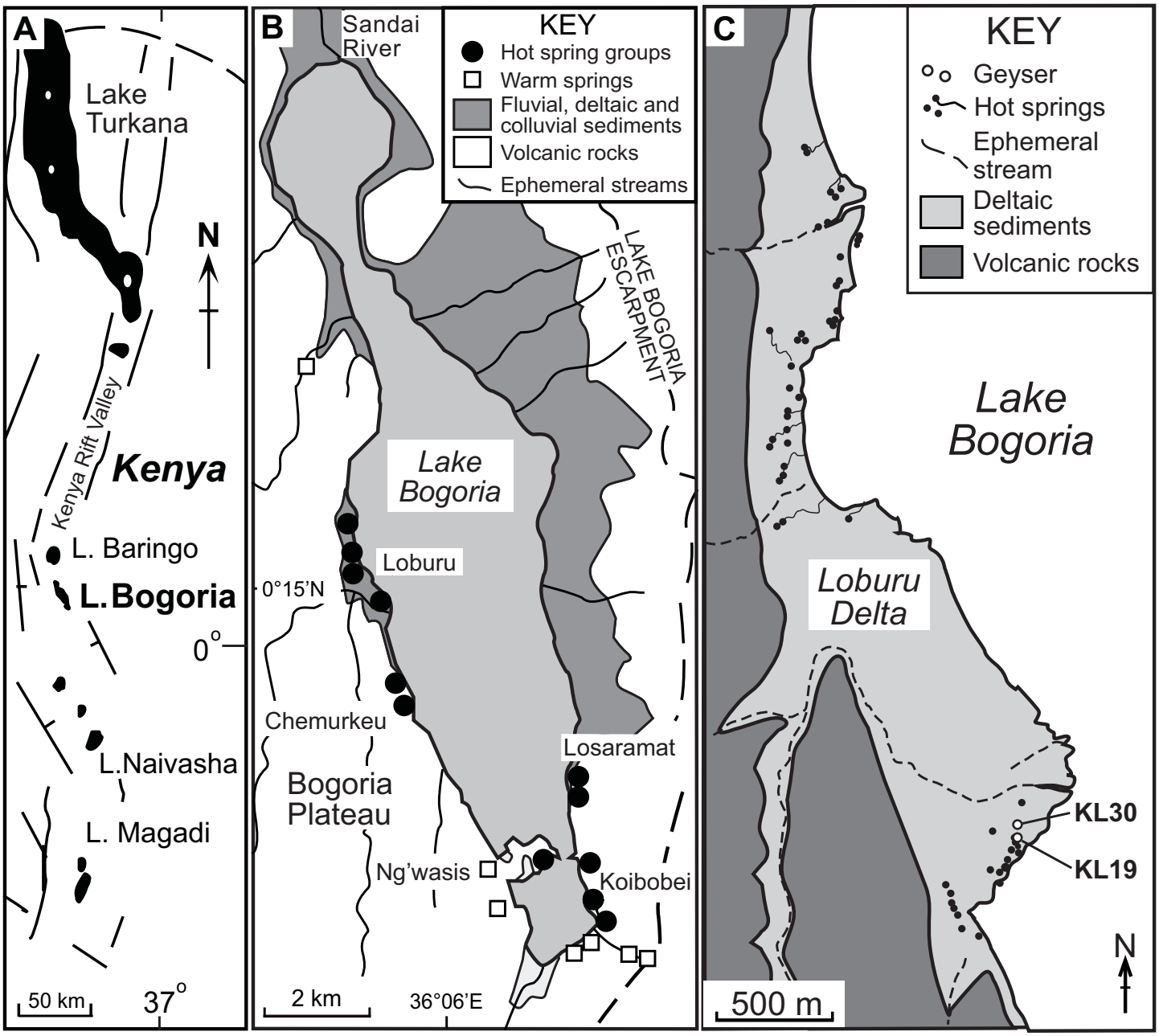


Figure 1. Location of the Loburu geysers. A: Kenya Rift Valley showing the location of Lake Bogoria. B: Location of Loburu and other hot-spring groups at Lake Bogoria. C: Distribution of the main hot springs at Loburu delta and location of the geysers.

the prevailing lake level; many vents are submerged when lake level is high. The northern group consists of about 32 springs, including three perpetual spouters, but there is no current (2005-7) geyser activity. About 11 of these springs have travertine deposits at their vents, much of which is fossil, but siliceous sinter deposits are absent except for thin, ephemeral opaline-silica crusts (Renaut et al., 1998). The southern group in August 2007 consisted of about 20 onshore hot springs with a few small offshore vents. Near the northern end of this group, a cluster of vents includes six geysers that were active at different times between August 2005 and August 2007.

The Southern Loburu Geysers

The southern Loburu delta-plain is a gently sloping surface composed mainly of bedded silts and sands, broken in places by small ephemeral stream channels and low wave-cut scarps. Most of the delta-plain surface consists of thin, pebbly, alkaline soils that are covered by patches of salt-tolerant grasses. Soft

Figure 2, right. Sketch map to show the relative positions of the southern Loburu geysers (August 2006). The location of KL19 and KL30 is shown on Figure 1.

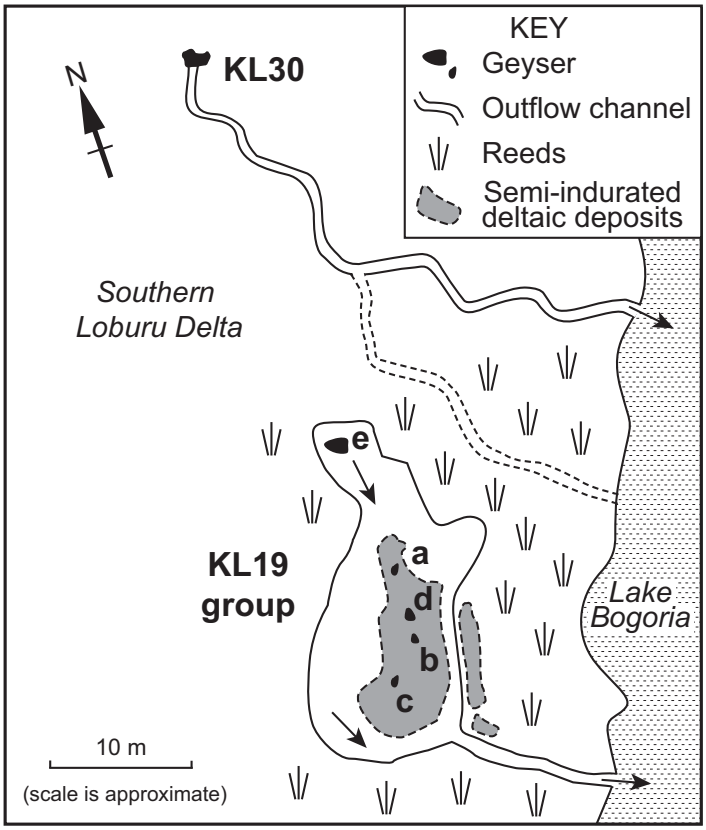
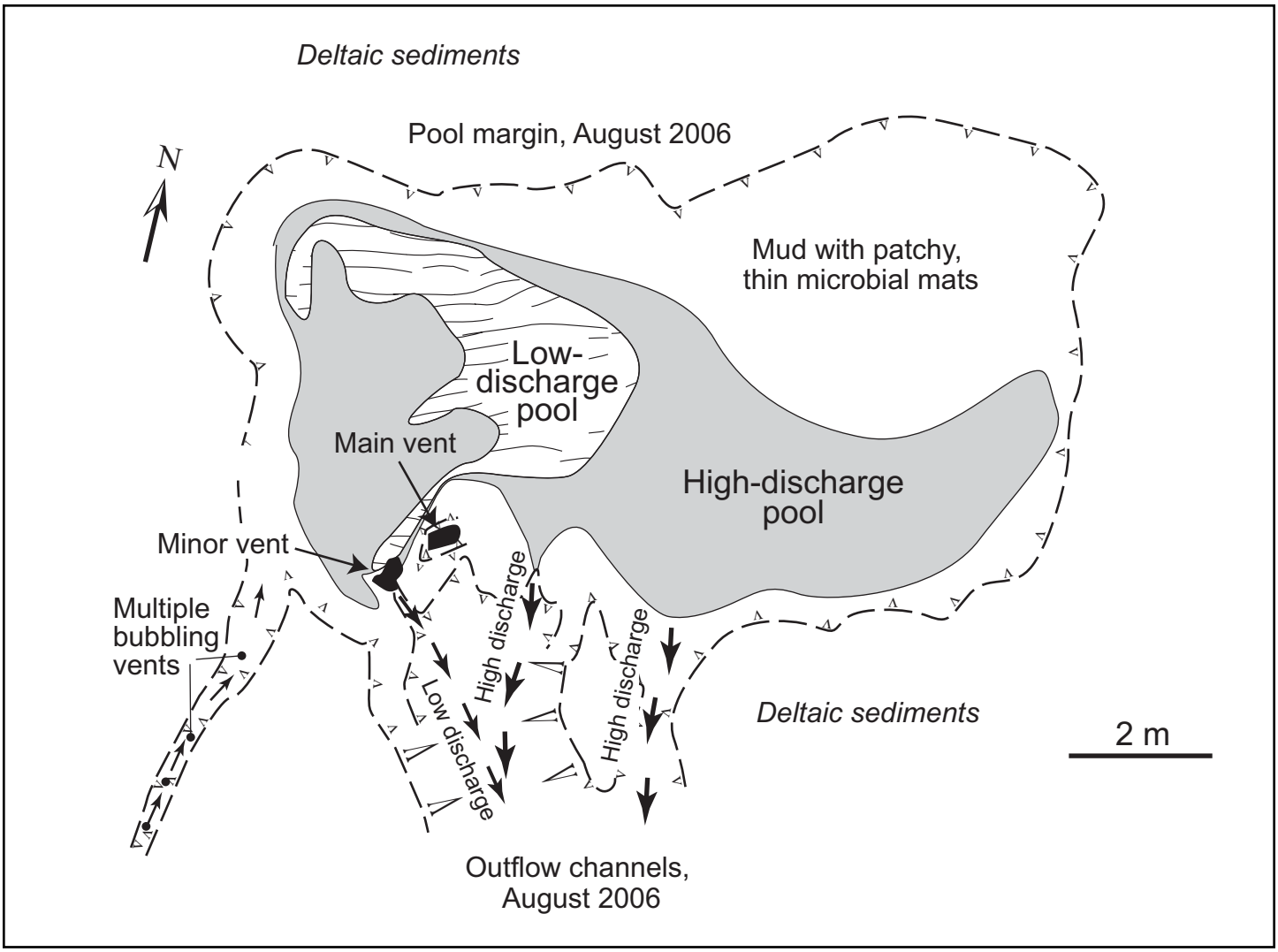


Figure 3, below. Plan of the vent area of geyser KL30 (August 2006). The high discharge pool shows the maximum extent of water during an eruption. The low discharge pool represents the area covered by water between eruptions. During eruptions water flows out of the pool through the high discharge channels, but flows only through the low discharge channel between eruptions.



swampy ground lies around some of the hot springs and in ephemeral stream channel floors. Most of the hot springs discharge quietly from shallow pools, 1–8 m in diameter, at measured temperatures of 39–98.5°C. A few springs are more than 2 m deep with steep plunging sides; others have cone-shaped vents with narrow, shallow platform margins, or nearly flat bases. All the active springs lie in reddish brown to pale brown deltaic silts, sands and muds.

Six geysers were observed during visits to the lake in August of 2005, 2006 and 2007. Five of these geysers lie in the KL19 group (*a*-*e*), together with geyser KL30. The vents of the KL19 group are only a few meters apart; KL30 lies approximately 30 m north of the KL19 group (Fig. 2).

Geyser KL30

Geyser KL30 lies in a small, shallow muddy depression in the delta-plain (Fig. 3). Over the three years of observations, the morphology and size of the vent pool increased significantly. In August 2005, the vent was located centrally in a shallow (20 cm) broadly circular pool approximately 3 m in diameter, with a single outflow channel toward the southeast.

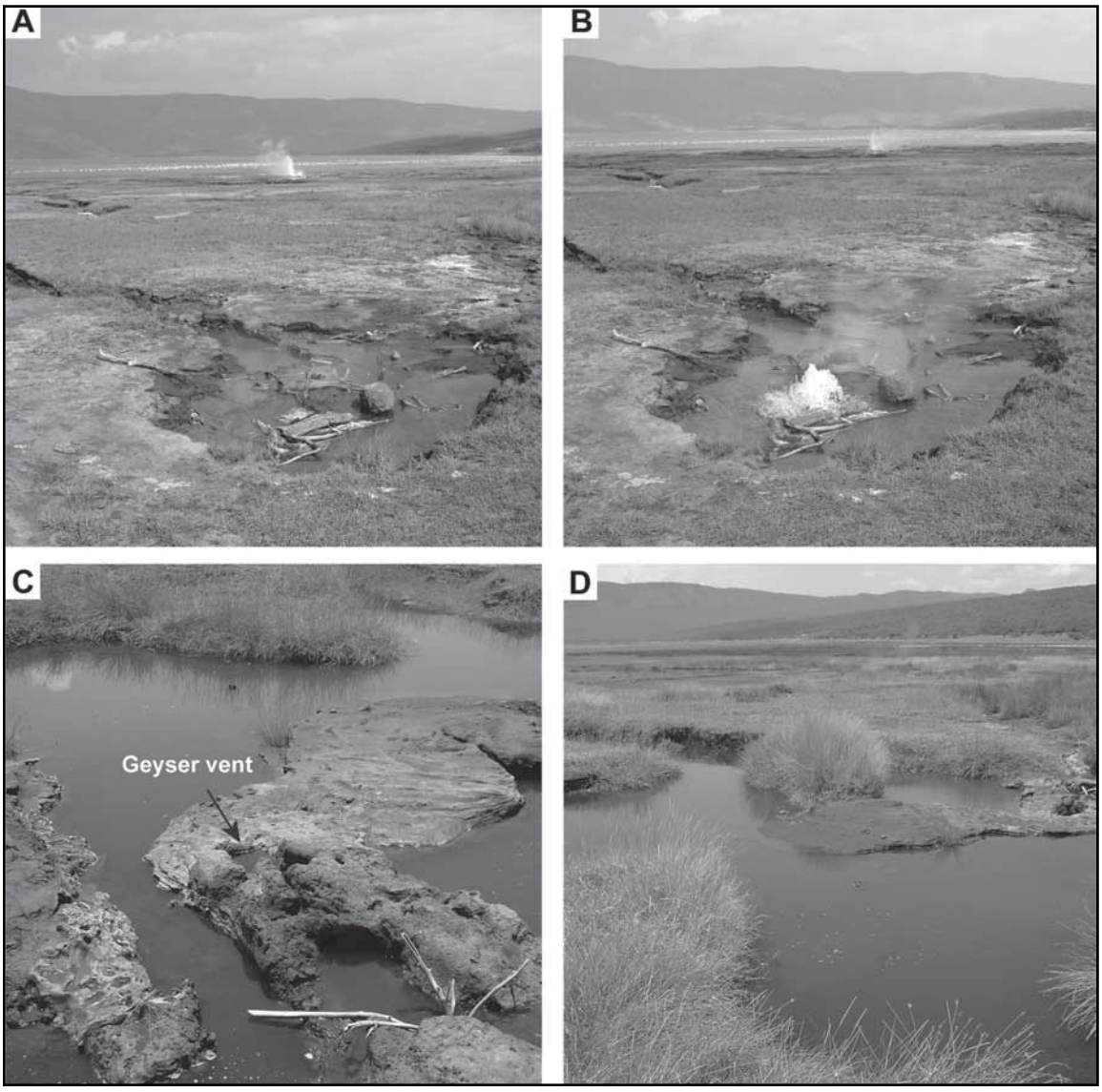


Figure 4. Geyser KL30 during 2005 and 2007. A: Vent pool of geyser KL30 during quiet stage between eruptions, looking south, August 2005. B: Geyser KL30 during a small eruption, looking south, August 2005. Local people commonly put wood and small boulders over the vent to try to stimulate eruptions. Both are visible in the pool. Geyser KL19*d* is active in the background. C: Vent pool, during August 2007, looking northeast. The vent is present in a small ridge of weakly lithified silts. D: Vent pool, during August 2007, looking south. The pool is flooded and has become a hot spring.