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Geotectonic Influences on the Lake Elementeita Ecosystem (Central Kenya Rift): Insights from Field and Space-Based Observations

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In the backdrop of the global freshwater crisis exacerbated by human activities and climate change, our study addresses the need to understand the forces shaping lacustrine ecosystems in Eastern Africa, particularly within the East African Rift System (EARS). The Lake Elmenteita basin in the Central Kenya Rift represents the intricate interplay between intense geotectonic forces and escalating human activities. This study aims to unravel the complex interactions shaping this critical ecosystem, with a particular emphasis on the geotectonic aspects that underpin the lake's environmental dynamics. Lake Elmenteita is ecologically vital, supporting a diverse habitat including numerous bird species and serving as a primary food source for up to half a million flamingos.

Our research employs a multidisciplinary approach, integrating tectonic geomorphology, geological remote sensing, geochemistry, soil science, and micropaleontology. This approach is designed to differentiate the lake's natural geological influences from anthropogenic impacts.

Field investigations have demonstrated that tectonic activity controls mobilization of soils and sediments, primarily through processes of uplift and exhumation. Additionally, fault zones are correlated with hydrothermal activity influencing element mobilization and distribution. This is particularly evident through fault-controlled thermal springs along the lake shore and within its catchment, notably in areas like the Kinangop Plateau. Here, intensive agriculture amidst complex faulting has heightened vulnerability to soil erosion. The geological diversity, marked by erodable trachytic tuffs and more resistant basaltic sources, dictates distinct erosion patterns, further compounded by deforestation. This deforestation is visible in Landsat time series data from 1984 to 2023, and particularly severe in the basaltic regions of the Aberdare Range, and trachytic regions of the Kingangop plateau indicating a correlation with increased agricultural activity.

Remote sensing analysis, using multispectral (Aster, Landsat, Sentinel) and topographic (TanDEM-X, Copernicus DEM) data, has been instrumental in mapping the lake's geological diversity and intricate fault network. The analysis highlights active fault zones, such as those along the NW sector of the Sattima fault and the Gilgil segment of the Kijabe fault. These faults are crucial in shaping the drainage patterns of the Kinangop plateau and influencing the hydrology of the lake.

The preliminary findings of this study place a spotlight on the dominant role of geotectonic processes in the environmental makeup of Lake Elmenteita, while also acknowledging the significant, albeit secondary, impact of human activities. By closely examining these combined forces, the research aims to contribute substantially to the understanding and management of this sensitive ecosystem. This insight is vital not only for Lake Elmenteita but also for other lacustrine systems within rift environments.