

The hydrochemistry of rivers in KwaZulu-Natal

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Abstract

The chemistry of the major elements of KwaZulu-Natal river water draining the eastern Drakensberg Escarpment was monitored in October 2003 and compared to data obtained previously along the western Drakensberg Escarpment, i.e. the Caledon and Upper Orange Rivers. The data obtained in these two surveys reveal no significant differences in the Mg, Ca, Na, K and HCO_3^- content of rivers draining similar lithologies, despite slightly different climatic regimes and different suspended loads. The implication is that lithology is the dominant control on the major element chemistry of river water draining the Drakensberg. However, in the north-western part of KwaZulu-Natal, drought-stricken at the time of sampling, evaporation-induced concentration results not only in evaporite formation, but dramatic changes in river and stream water chemistry. Elevated levels of minor constituents such as NO_3^- also indicate that in cultivated areas anthropogenic activities have an impact on water quality and composition.

Keywords: KwaZulu-Natal, hydrochemistry, river water, Drakensberg, lithology

Introduction

The chemistry of unpolluted freshwater systems such as rivers is primarily controlled by the lithology of the drainage basin and weathering stoichiometry (Meybeck, 1987; Dupré et al., 2003). Changing land-use patterns in Southern Africa, together with climate change, will almost certainly impact on erosion rates and chemical weathering processes, with important implications for river suspended and dissolved loads (Legesse et al., 2003). Southern Africa in general and the high-relief and erodable sedimentary layers of the Drakensberg Escarpment in particular, are extremely susceptible to such change (Keulder, 1979). Its impact on the quality of freshwater, our most valuable natural resource, can only be assessed and reliably predicted if the fundamental controls on river water chemistry are understood (Day and King, 1995; Scharler and Baird, 2003).

A study of the correspondence between river water strontium isotope ($^{87}\text{Sr}/^{86}\text{Sr}$) composition and dominant drainage basin lithology in the Orange-Caledon-Vaal River system (De Villiers et al., 2000), demonstrated the extent to which river water chemistry is controlled by lithology. This study investigates whether the relationship between river water chemistry and lithology demonstrated for rivers draining the western Drakensberg Escarpment, i.e. the Caledon and Upper Orange Rivers, holds along the eastern Drakensberg Escarpment. Most of the rivers sampled in KwaZulu-Natal drain rocks of the Karoo Supergroup, i.e. the same lithological provinces as the Caledon and Upper Orange Rivers. Given that catchments along the eastern Drakensberg Escarpment experience higher average annual rainfall than along the western escarpment, this study also provides an evaluation of the possible secondary role of climate on chemical weathering processes and river chemistry. River water runoff provides most of the freshwater used for human, agricul-

tural and industrial utilisation in KwaZulu-Natal, and the results are therefore also of direct relevance to the assessment of water quality for these purposes (DWAf, 1996; Lin et al., 2004).

Geology of the catchment area

The basal Karoo sequence consists of the Dwyka Formation (tillite-dominated), overlain by the carbonaceous shale, dolomite, mudstone, siltstone and organic-rich layers of the Ecca Group (Smith, 1990; Johnson et al., 1996). Above this is the Permian-Triassic Beaufort Group (alternating calcareous and non-calcareous mudstone), including the coarse sandstone-dominated Upper Triassic Molteno Formation. This is followed by the Elliot and Clarens Formations (fine-grained red beds and yellow sandstone) which in turn are capped by the Drakensberg Group (Jurassic flood basalt). The rivers originating in the easternmost part of KwaZulu-Natal drain primarily rocks of the Natal Group and Natal metamorphic belt.

Climate and geography of the catchment area

Rainfall in KwaZulu-Natal is strongly seasonal with more than 80% falling between October and March (WRC, 2002). This sampling survey was conducted during October, i.e. before the rainy season and additionally, towards the end of one of the most severe droughts on record in the north-western part of KwaZulu-Natal.

In the west, i.e. the vicinity of the Drakensberg Mountain, the terrain varies from high mountains (average altitude of 1 600 m) to undulating hills and lowlands (WRC, 2002). Soils are mostly well-drained. The average air temperature is 15°C, mean annual precipitation (MAP) 720 mm and mean annual runoff (MAR) 195 mm (WRC, 2002). Towards the east the terrain becomes a mix of highly dissected low mountains and lowlands (average altitude 650 m). The average air temperature is 18°C, MAP 890 mm and MAR 100 mm. Soils here consist of a greater proportion of shallow and poorly drained soils. Along the coastal plains the average altitude is < 200 m and the soils consist predominantly of shallow soils on well-weathered rock.

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