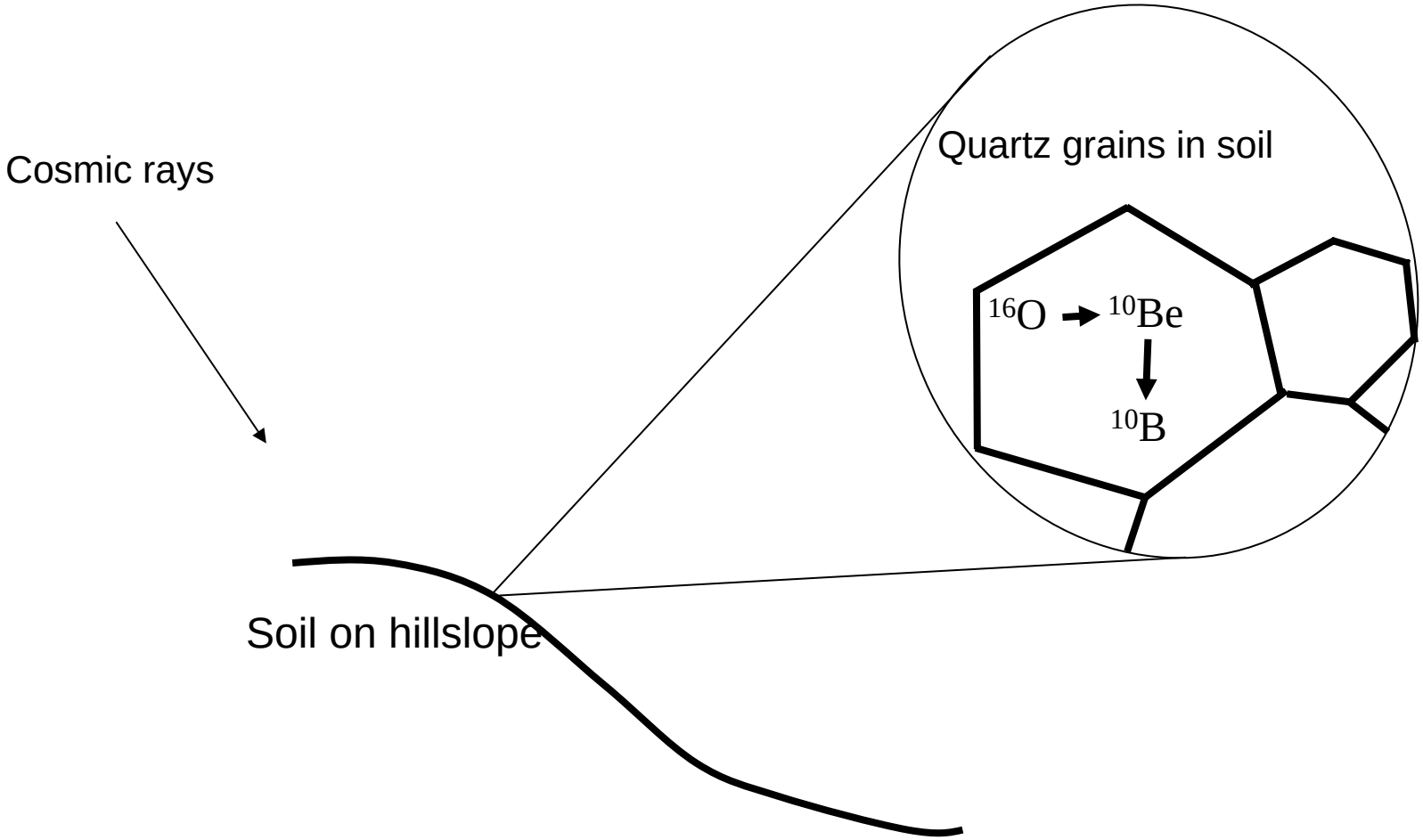
Long-term erosion rates across Kruger National Park

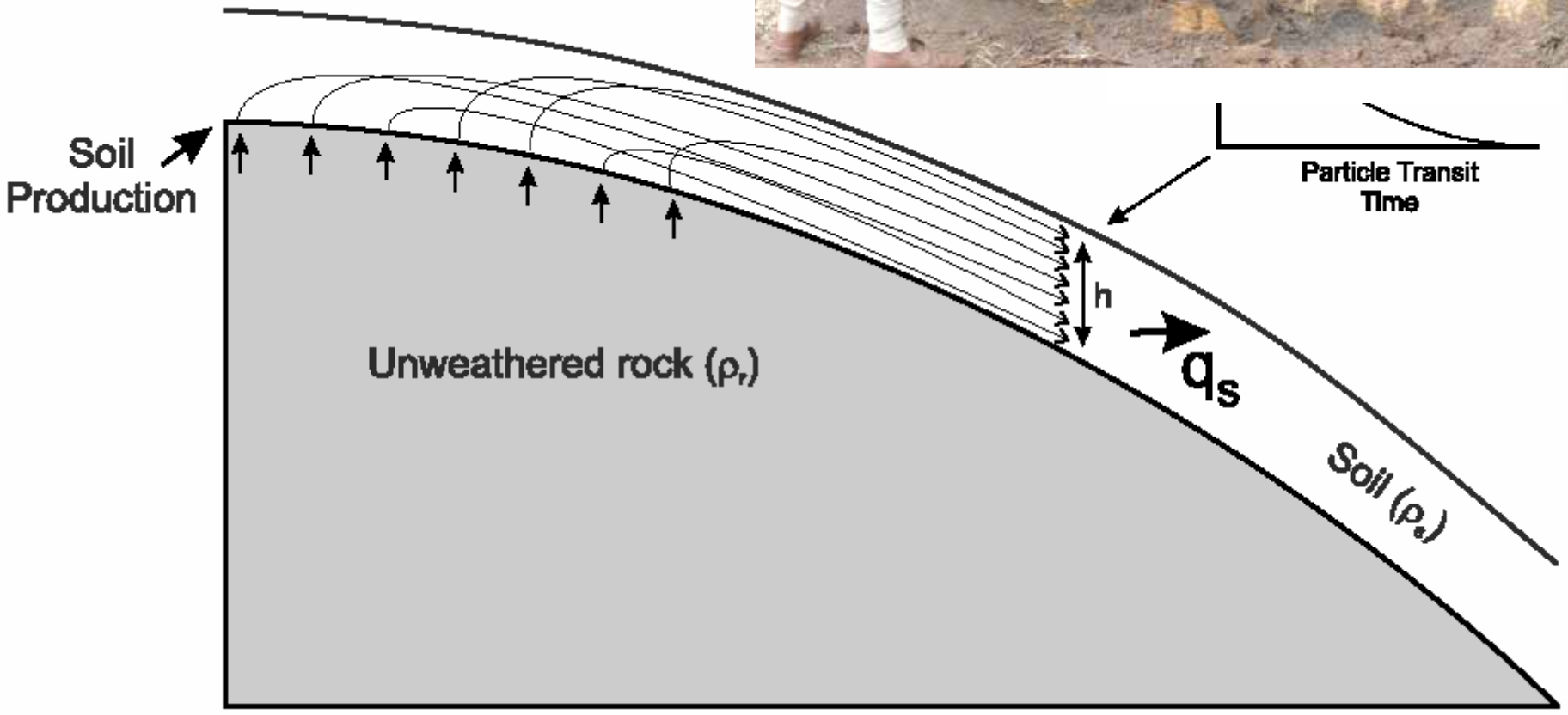
Oliver Chadwick, Tony Hartshorn, Lesego Khomo, Arjun Heimsath

Measuring erosion rate with cosmogenic isotopes



- Production rate of ^{10}Be from decay rate (half-life = 1.5 Ma)
- Attenuation length of cosmic rays, altitude
- Calculate erosion rate based on number ^{10}Be atoms accumulated in Quartz

Measuring erosion rate with cosmogenic isotopes



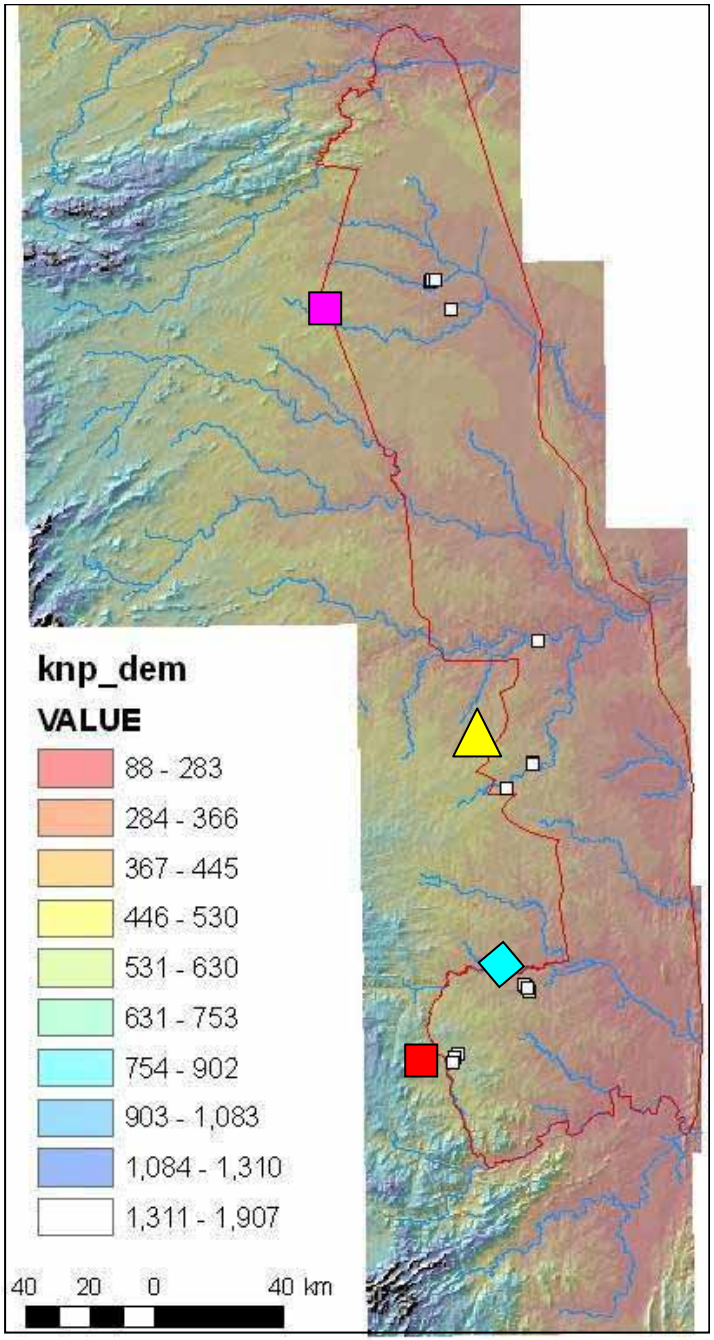
Erosion rates estimated by two samplings

- ^{10}Be counted in channel sands
- ^{10}Be counted at the point where rock→soil

Erosion Rate

- Units

units:
meters / million years
m/My
=
millimeters/thousand years
mm/ky

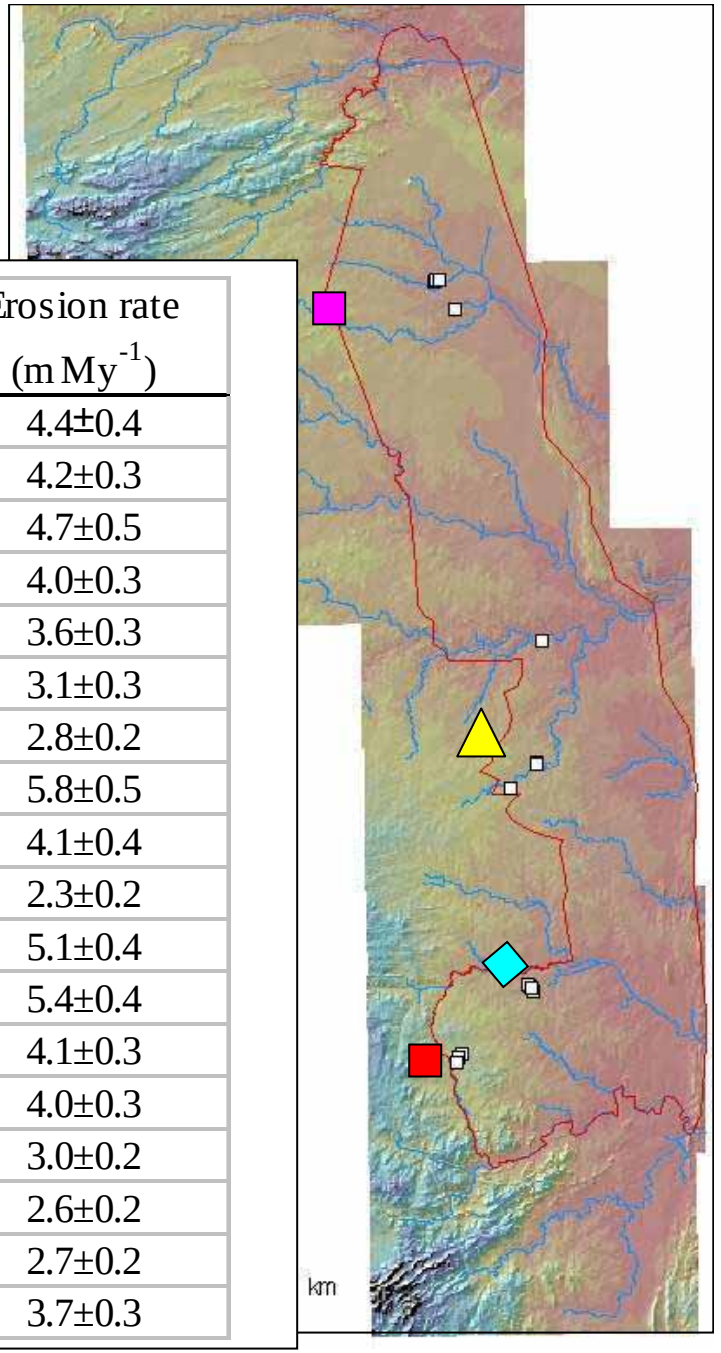


Catchment-averaged rates from channel sands

Erosion Rate

- Area Average

Climate zone (effective precipitation)	Sample	Latitude (°S)	Longitude (°E)	Erosion rate (m My^{-1})
Phugwane River, 0.15	KR-15	23.04731	31.22885	4.4±0.4
	KR-16	23.04601	31.22969	4.2±0.3
	KR-17	23.04382	31.23538	4.7±0.5
	KR-18	23.04266	31.24283	4.0±0.3
	KR-19	23.12359	31.28887	3.6±0.3
Timbavati River, 0.18	KR-26	24.47147	31.44409	3.1±0.3
	KR-25	24.46902	31.44328	2.8±0.2
	KR-22	24.39836	31.52199	5.8±0.5
	KR-23	24.40063	31.52252	4.1±0.4
	KR-20	24.05547	31.54384	2.3±0.2
Nwatsisaka River, 0.20	KR-1	25.02467	31.49468	5.1±0.4
	KR-2	25.01957	31.49136	5.4±0.4
	KR-5	25.03020	31.50182	4.1±0.3
	KR-4	25.03635	31.50405	4.0±0.3
Nsikazi River, 0.27	KR-6	25.21217	31.28210	3.0±0.2
	KR-8	25.22028	31.27250	2.6±0.2
	KR-7	25.22153	31.27175	2.7±0.2
	KR-11	25.23586	31.26652	3.7±0.3



Catchment-averaged rates from channel sands

Erosion Rate

▶ Area Average: **x = 3.5 m My^{-1}**

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Phugwane River, 0.15	KR-15	23.04731	31.22885	4.4 ± 0.4
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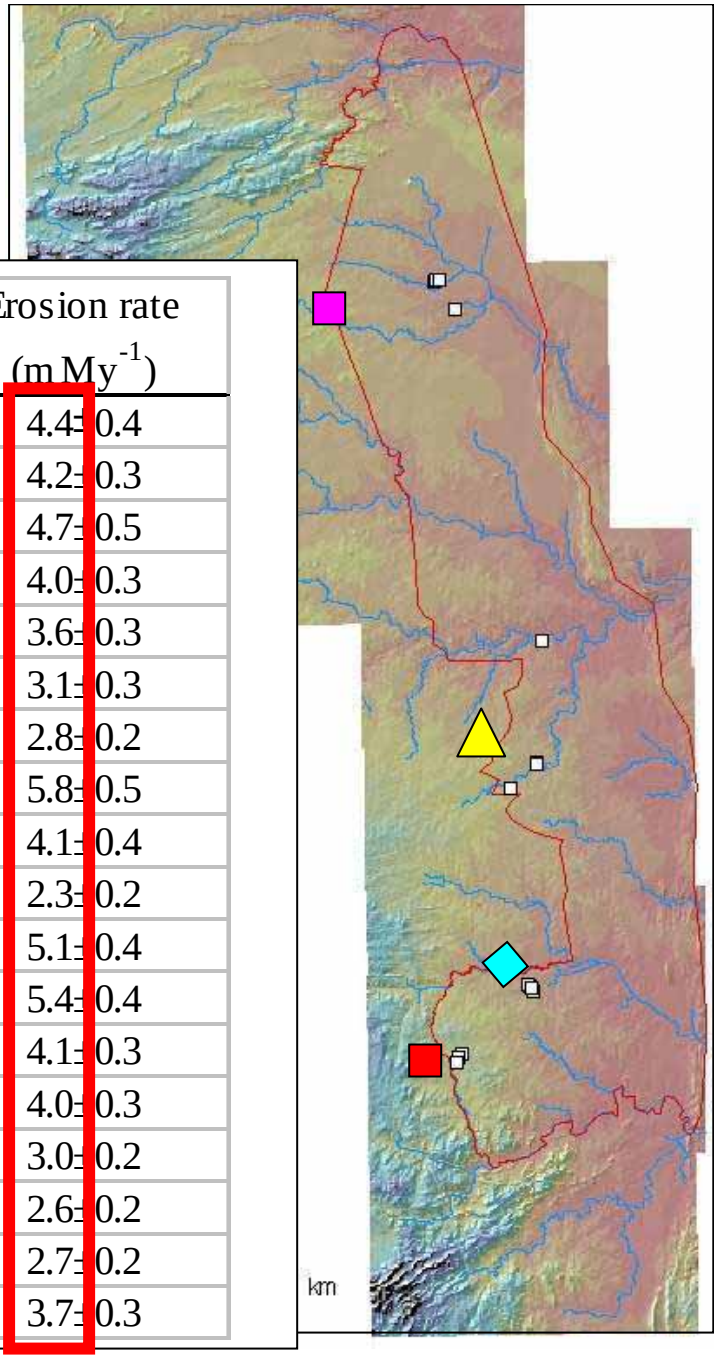
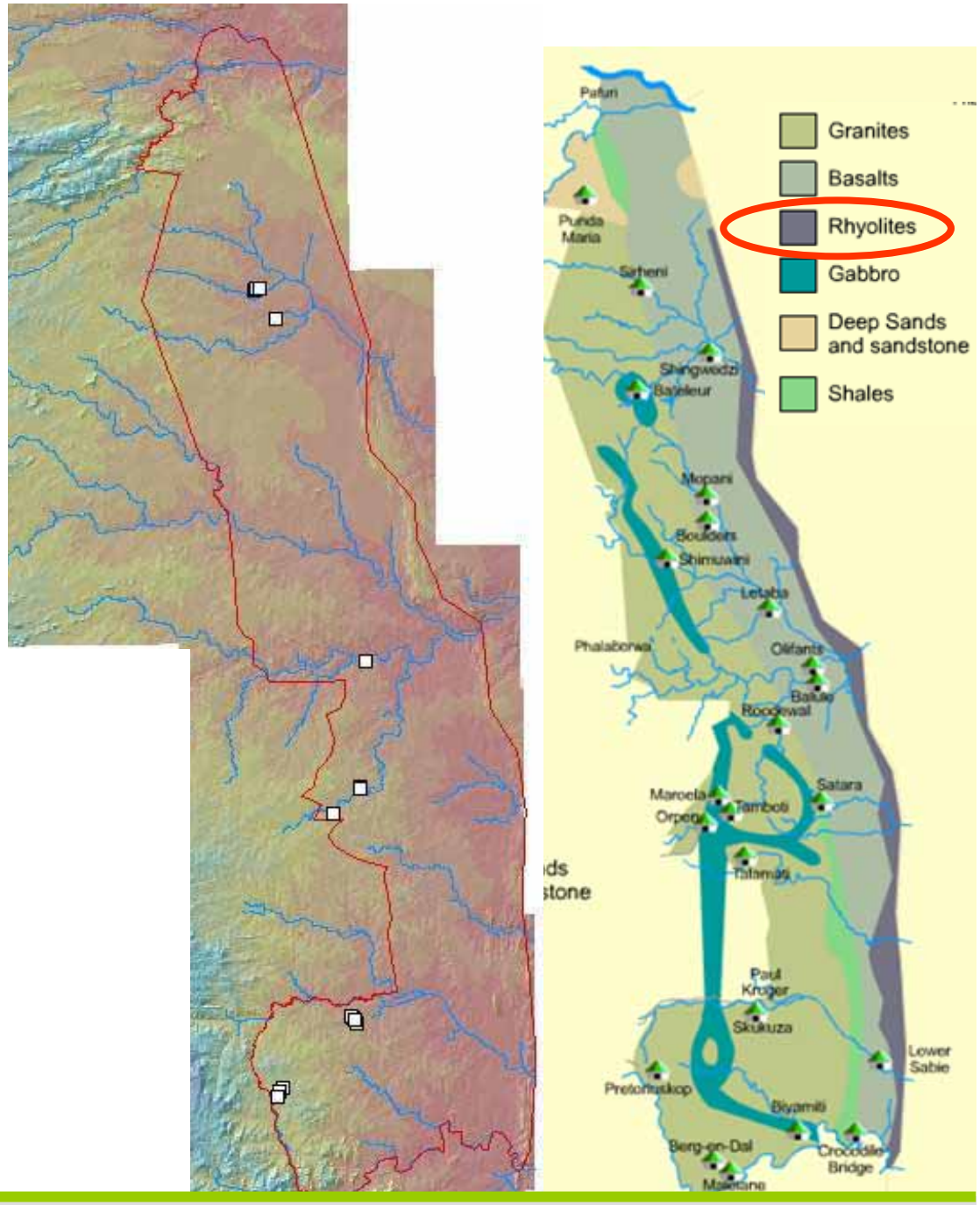


Catchment-averaged rates from channel sands

Why such low rates?

Because the 180 My rhyolite of the Lebombo Mountains (Jonzini formation) sets local base level



Feedbacks & implications

Soil residence times (catchment-averaged rates)

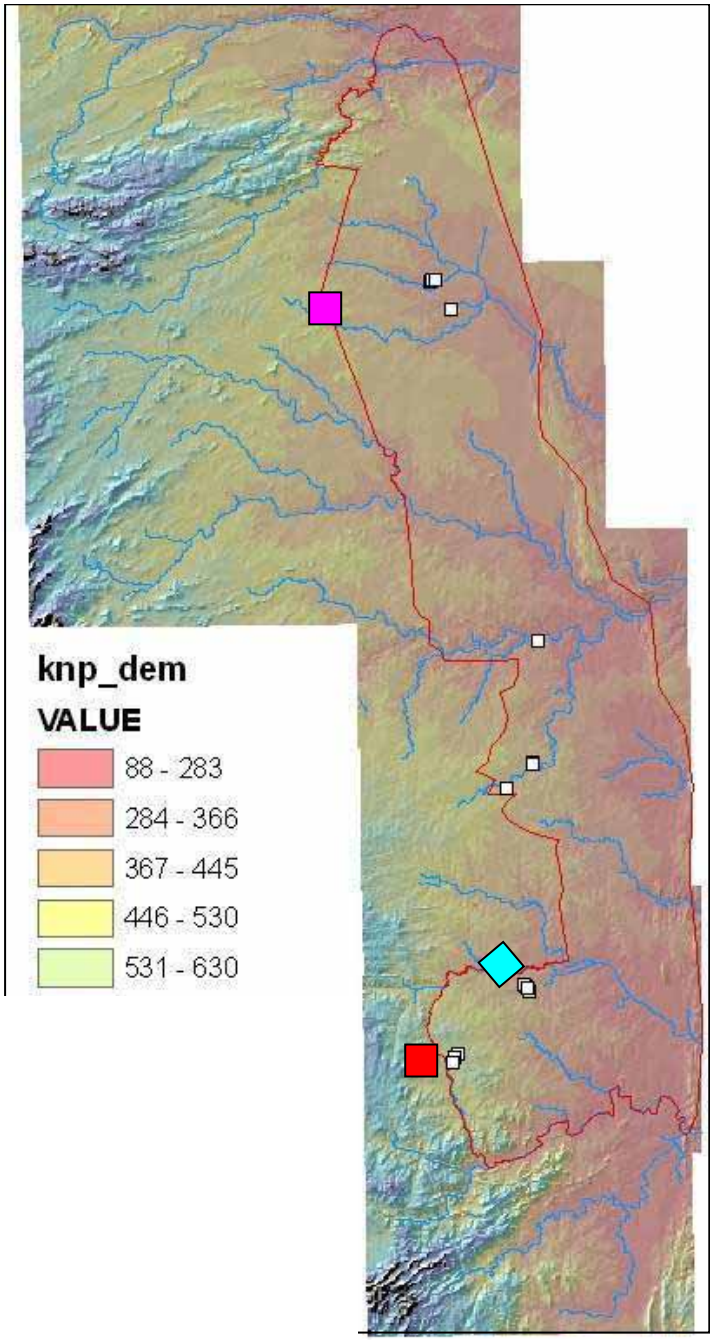
- Methods: ^{10}Be

soil depths average 0.7 m &
erosion rates average 3.5 m My^{-1} (n=18)

$$\frac{0.7 \text{ m}}{3.5 \text{ m } My^{-1}} \equiv 0.2 \text{ My or } 200{,}000 \text{ yr}$$

→Average KNP soil residence times ~ 200,000 yr

→How much does residence time vary spatially?



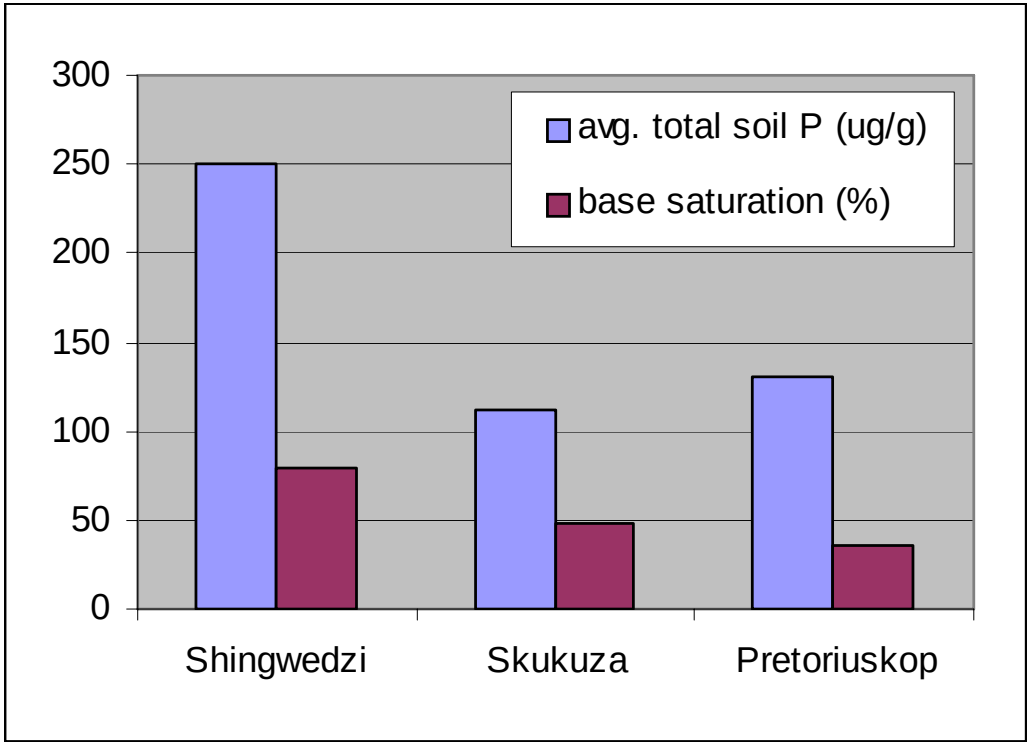
Soil residence times (SRT) on crests

Climate zone	SRT (ky)
Shingwedzi	294
Skukuza	201
Pretoriuskop	1140

Soil residence times from soil production rates

Rock-derived nutrients

- Phosphorus limits ecosystem productivity
- Supply of rock-derived nutrients driven by a mix of climate and landscape lowering



Physical vs Chemical Erosion

Erosion is bad except when it is good

Physical removal rejuvenates ecosystems by exposing nutrient-rich rock

Chemical removal leaves a residue of nutrient-poor soil material

Kruger granites are impacted by chemical removal leading to nutrient impoverishment particularly in Pkop