MARKHAM RIVER FLOODPLAIN SEDIMENTS REVEAL LAST GLACIAL MAXIMUM EROSION IN PAPUA NEW GUINEA UPLANDS FOLLOWED BY LANDSCAPE STABILITY

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The Markham River drains a catchment of 12800 km^2 in northern Papua New Guinea and flows into the Huon Gulf south of Lae. The catchment extends from the Finisterre and Saruwaged Ranges in the north to the Ekuti Range near Wau in the south. Major tributaries are the Erap, Leron and Gusap Rivers from the north and the Bulolo and Watut Rivers from the south. The Markham River is braided where it flows across the broad floodplain of the fault-controlled Markham Valley.

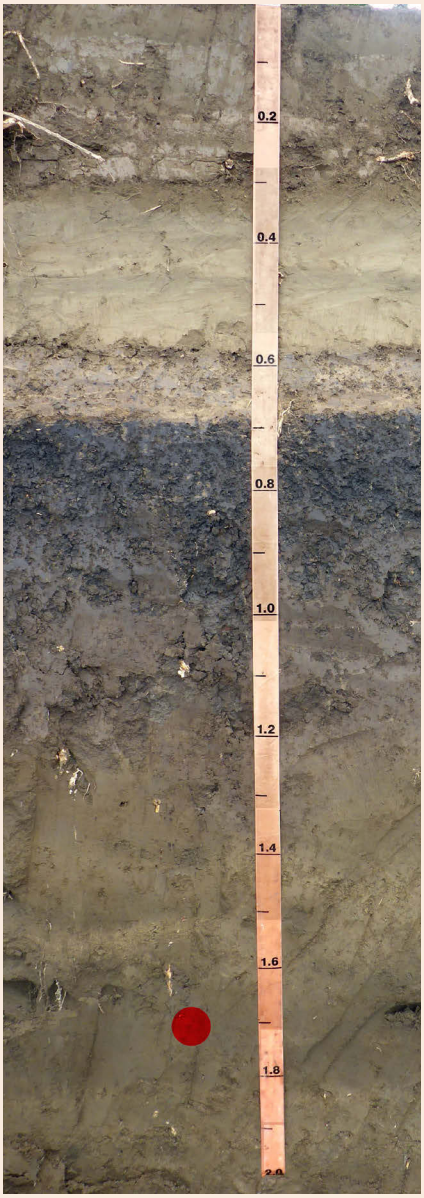
Palaeosols are prominent in the banks of the Markham River. Near the village of Ganef (146.6448°E 6.6266°S), situated 10 km southwest of Nadzab (Lae) airport, deep sandy sediments containing a very prominent clayey palaeosol (Figure 1). This suggests a period of rapid sedimentation on the Markham River floodplain, followed by a long period of organic matter accumulation, weathering and a low sedimentation rate, followed by renewed higher rates of sedimentation. The section was described (Table 1) and an undisturbed sample (WLL1401, Victoria University of Wellington, New Zealand) was taken from 1.7 m depth (see red dot in Figure 1) using an aluminium tube, in order to ascertain the age of the major sedimentation event by optically-stimulated luminescence (OSL). Blue luminescence was measured during infrared stimulation of fine grain (4–11μm) feldspar, using the Single Aliquot Regenerative method (SAR) as described by Murray and Wintle (2000).

Table 1: Profile description.

SOIL HORIZON	DEPTH (cm)	HORIZON DESCRIPTION (Australian Soil and Land Survey handbook, 3rd edition 2009)
AC	0–30 cm	Olive grey (5Y4/2) (moist) silty loam (25% clay est.) with bands of clay showing sedimentary layering (platy structure); weak strength; strongly developed angular blocky peds 20–40 mm diameter; common very fine and fine roots, few coarse and medium roots.
C1	30–46 cm	Olive (5Y5/3) (moist) loamy sand; very weak strength; single grain; few very fine and coarse roots.
C2	46–58 cm	Olive (5Y5/3) (moist) with 2 cm thick olive (5Y4/2) band at top of horizon; loamy sand; very weak strength; single grain; few roots of all sizes.
2ACB	58–70 cm	Olive (5Y4/2) (moist) silty clay (35% clay est.); firm strength; strongly developed subangular blocky peds 8–10 cm diameter; few very fine and fine roots.
3A1B	70–100 cm	Grey (2.52.5/1) (moist) clay (50% clay est.); firm strength; strongly developed subangular blocky peds 10–20 mm diameter; very few very fine, fine and medium roots, no coarse roots.
3B1B	100–120 cm	Very dark grey (2.5Y3/1) (moist) silty clay (40% clay est.) with 60% dark olive brown (2.53/3) mottles 8 mm diameter; very firm strength; weakly developed angular blocky peds 50–100 mm diameter; common very fine and fine roots, few medium and coarse roots.
3B2B	120–140 cm	Dark olive brown (2.5Y3/3) (moist) silty clay (25% clay est.); weak strength; very weakly developed angular blocky peds 100 mm diameter; few very fine and coarse roots.
3CB	140–160 cm	Light olive brown (2.5Y5/3) (moist) loamy sand; weak strength; single grain; very few very fine, fine and medium roots, no coarse roots.
4A1B	160–183 cm*	Olive brown (2.5Y4/3) (moist) loamy sand; very weak strength; single grain; few roots of all sizes.
4CB	183–250 cm	Brown (10YR4/3) (moist) silty clay (50% clay est.) with 40% olive (5Y4/3) mottles 10 mm diameter; weak strength; massive; few very fine and fine roots.

*OSL sample taken at 1.7 m.

Figure 1: The floodplain profile on the north bank of the Markham River at Ganep. Several palaeosols are visible and the four most obvious of these are described in the profile description (Table 1). The most prominent palaeosol (3A1b horizon) is that at 70–100 cm depth. The red dot marks the sample position for OSL dating, within the palaeosol (4A1b horizon) at 160–183 cm depth.
(Photo credit: Peter McIntosh)



The external dose rate was determined on the basis of gamma spectrometry measurements.

The sands at 1.7 m depth (red dot) were OSL dated at 23 300±1900 years before present (2019) (Table 2).

Assuming complete resetting of the OSL signal in the sands at deposition (which is likely given the length of the Markham River and its turbulent flow) this date indicates that there was major erosion in the Markham River catchment during the Last Glacial Maximum (LGM) c. 24 000–18000 years ago, when the highest points of the Saruwaged Range were glaciated (Prentice et al. 2011) and seasonal snow melt and patchy vegetation cover in the higher parts of the catchment probably caused widespread upland erosion. The most probable sequence of events is that sediment derived from upland erosion accumulated at Ganef in regular floods during the LGM, but slowed or stopped in the early Holocene when upland areas were stabilised by forest cover. This allowed a well-developed carbon-rich soil to form (probably under forest vegetation), along with weathering of sediments to clays. The palaeosol was then buried by a resurgence of sedimentation, probably corresponding with vegetation burning and land clearing for European-style farming in the early twentieth century.

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Table 2: Water content, radionuclide contents, a-value, equivalent doses, dose rate and luminescence age.

LAB. CODE	WATER CONTENT (%)	U (ppm)	TH (ppm)	K (%)	A-VALUE*	DE (Gy)	DOSE RATE** (Gy/ka)	OSL AGE (ka)
WLL1401	25.2±6.3	0.80±0.10	2.43±0.06	0.93±0.02	0.06±0.03	31.65±1.07	1.36±0.10	23.3±1.9

*The a-value is estimated
**The total dose rate includes cosmic dose rate of 0.1544±0.0077Gy/ka