

# Soil Block 909 Kuk Swamp

Soil block 909, 'Phase 2'/7000-6400 cal BP  
palaeosurface feature fill  
Polished billet, impregnated soil offcut, resin-  
impregnated soil block, thin section (1999)  
Kuk Swamp, Upper Waghi Valley, Papua New  
Guinea  
Resin, soil, 4.8 x 2.6 cm  
SoAA Archaeology Collection

New Guinea has evidence for some of the oldest agricultural practices in the world, comparable to Southwest Asia, China and Central America. The highlands of New Guinea are among a handful of landscapes globally that demonstrate a semi-continuous agricultural history from the inception of cultivation in the early Holocene some ten thousand years ago and extending to the present day. The antiquity and long-term history of agriculture is preserved in the soils of the New Guinea Highlands. The actions of people clearing forests, planting, preparing plots, digging ditches, constructing mounds, and harvesting over millennia leave traces in the soil. Soils are the physical intersection of environmental histories and human landscape management practices and thus are excellent repositories of landscape memory.

The objects in this photograph derive from a soil block from the site of Kuk Swamp, Upper Wahgi Valley, a UNESCO World Heritage listed site and the 'type-site' of early agriculture in New Guinea (see Denham et al. 2003; Denham 2018; Golson et al. 2017). During field excavation in the 1990s, the soil block was carefully carved out and removed intact from archaeological stratigraphy. Arriving in the laboratory, the soil block was impregnated with resin, rendering the slice of stratigraphy inert to decay. The soil block is analysed using micro-stratigraphic techniques of the archaeological sciences which study the stratigraphy in its undisturbed

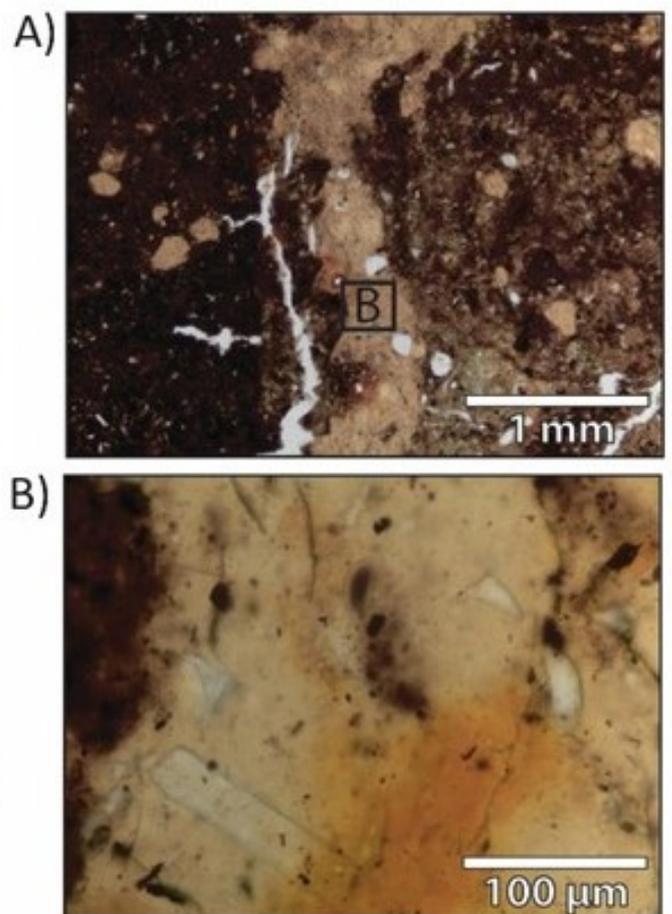
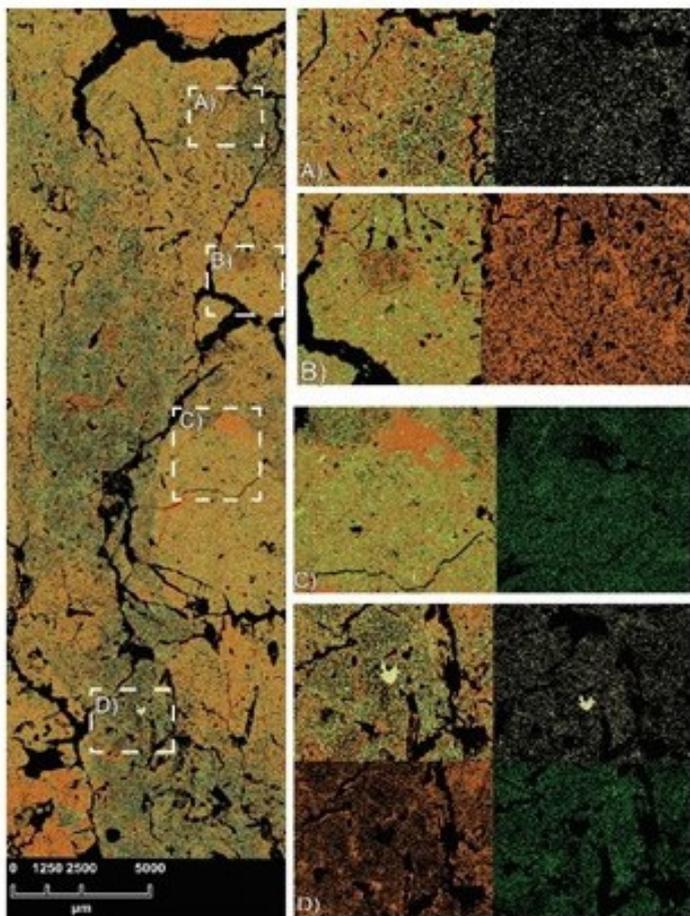
*in situ* arrangement at high resolution, thus enabling reconstruction of processes which formed the stratigraphy over time. Here, resin blocks (middle left and middle right) are scanned using X-Radiography to reveal masked sedimentary structures in deposits that appear massive and homogenised to the naked eye (Denham et al. 2009). A thin section (right) is made by slicing thirty microns – less than one-thirtieth of a millimetre – of the soil block and securing it to a glass slide for observation under a microscope, a technique called micromorphology (Denham and Grono 2017). A polished billet (left) is analysed using an automated quantitative and spatial mapping technology called QEM-SCAN to produce microscopic mineral and elemental maps of the soil.

The sample pictured here was removed from the fill of a feature on a mounded palaeosurface dating to 7000-6400 cal BP. We use microscopy (thin section analysis) and an automated scanning electron microscope called QEMSCAN® (Quantitative Evaluation of Minerals by Scanning Electron Microscope) to observe components *in situ* and identify processes in the formation and development of the feature fills (see Denham and Grono 2017; Mason et al. submitted). These analyses reveal extensive heterogeneity of the fill including admixture of sedimentary sources and displaced materials which suggest human burning and digging activities related to mound construction and plant cultivation

on adjacent palaeosurfaces (see figure 1). Sediments in the fill originate from inwashed, rolled and slumped material from the edge of newly constructed, unvegetated mounds. They include an abundance of grass phytoliths (silica cells formed inside plants) indicating grasses dominated the local vegetation at this time, and were cut, cleared, burnt and/or mulched during mound construction, and the detrital plant materials accumulated in the adjacent fills such as this one. The QEMSCAN mineral map of the fill provides a readily interpretable visualisation of soil formation processes, showing an admixed distribution reflected in kaolinite-rich and smectite-rich zones and *in situ* physical admixture. Following infilling, the feature retains many original pedogenic characteristics such as channel voids from roots and faunal burrowing that suggests the feature was not homogenised, making it more reliable for dating and palaeoecological

analyses.

The micro-stratigraphic techniques allow microscopic processes in the soil to be matched with landscape features recorded during archaeological survey and excavation. They establish the depositional context and chronological security of cultivated plant remains and reconstruct the sequence of landscape management and cultivation practices at Kuk. During Phase One (10,000 years ago) forest clearance, plant exploitation of wetland vegetation, and potential swidden cultivation involving the preparation of plots, digging of tubers and staking of plants took place. Phase Two (7000 to 6400 years ago) involved plot preparation using mounds (raised 'beds') for the cultivation of plants such as taro (*Colocasia esculenta*), yams (*Dioscorea* spp.), bananas (*Musa* spp.) and sugarcane (*Saccharum officinarum*). Phase Three



Images from microscopy analysis of the soil block. Left: QEMSCAN mineral map showing the distribution of clay minerals, reflecting heterogeneity and admixture of materials. Kaolinite: orange. Smectite: green. Right: Photomicrographs from thin section microscopy: (a) Heterogeneity of the fill, showing displaced grey clay granules and a vertical channel formed by faunal burrowing and later infilled with secondary grey clay. (b) Magnification of clay infill showing an abundance of silica bodies of grass phytoliths.

(4000 years ago to the recent past) involved repeated construction of ditch networks for drainage and cultivation.

The evidence preserved in the soil, among other multidisciplinary lines of investigation at Kuk, tells an 'unexpected and strange' (Denham 2018, pp. 4) story of early agriculture. This story goes against-the-grain of traditional accounts of how, where and why agriculture arose. Geographically isolated from the presumed 'centres' of early agriculture in the 'Old World', New Guinea was a centre of plant domestication for globally significant crops such as bananas (*Musa spp.*) and sugarcane (*Saccharum officinarum*). New Guinea plant practices centred on vegetative propagation, namely clonal reproduction using plant parts, such as, rhizomes, tubers, suckers and stem sections) rather than sexual reproduction from seed, which is characteristic of agricultural practices based on cereals and legumes. New Guinea early agriculture was not associated

with major technological or social thresholds, such as cereals, pottery, animal domestication the emergence of socio-political complexity, traits traditionally presumed to usher in 'the rise of civilisation'. By destabilising the Eurasian-centric, evolutionary-progressive story of agriculture, the New Guinea story celebrates the global diversity of plant-human interactions in the past.

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