Discovery of Middle Pleistocene fossil and stone tool-bearing deposits at Groot Kloof, Ghaap escarpment, Northern Cape province

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We report the discovery of a major fossil-bearing and archaeological complex of karstic deposits at Groot Kloof in the escarpment of the Ghaap Plateau, around 100 km southwest of Taung. The region is known for open fluvial and lacustrine sites sampling Lower and Middle Pleistocene tool types and the long, but discontinuous sequence of Wonderwerk Cave. Research at Groot Kloof has concentrated on two of four localities. One locality has yielded fossils from the Florisian Land Mammal Age and lithics that may sample a late Early Stone Age/early Middle Stone Age type industry. The second locality has been dated using U–Th to 248 ± 37 kyr ago for fossil-bearing tufa, and normal magnetic polarity for various tufa and breccia. The occurrence of fossils embedded within tufa rather than infilling a cavity is unusual. Small pockets of Later Stone Age artefact-bearing breccia and rock art also occur. The significance of Groot Kloof is underscored by current debate about the emergence of modern humans in which the appearance of modern behaviour is posited to have occurred in this and other regions during this part of the Middle Pleistocene.

Introduction

In January and June 2004, one of us (D.C.) located and surveyed several large bodies of fossiliferous and lithic-bearing breccia at Groot Kloof (28.350°W, 24.183°S) located on land owned by Holcim (Pty) Ltd, near Delportshoop, 60 km northwest of Kimberley, Northern Cape province (Fig. 1). In June 2005, a multi-disciplinary project involving Australian, British and South African researchers began with the aim of investigating the palaeoanthropological potential of these deposits. The Ghaap escarpment and the plateau are also being surveyed.

Groot Kloof is a complicated fossil-bearing and archaeological sequence related to a tufa waterfall complex within the escarpment of the Ghaap Plateau (Fig. 1). From a palaeoanthropological perspective, the most notable feature of this plateau karst is the development of massive tufa fan deposits along its escarpment. These are most prominent near Taung (Buxton-Norlim, Witkrans and Thoming), Delportshoop (Ulco, Groot Kloof and Gorrokop) and Douglas (Mazelsfontein).[1]

The anthropological potential of such deposits has been known since before the discovery of the first African hominin (the Taung Child) at Buxton-Norlim in 1924.[2] Other fossil-bearing localities such as Fossil Hill near Boetsap have also been known since the mid-20th century,[1] but these are of a limited extent and their dating is problematic. In many cases, this is because fossiliferous deposits are located within infilled tufa cavities. Lime mining of tufa deposits has also obscured the stratigraphy in many cases at these sites. However, much potential remains for the discovery of fossil-bearing and archaeological deposits from the Pliocene and Pleistocene, as demonstrated around Taung.[3–8]

In addition to the tufa deposits near Taung, the region is known for open localities sampling the Pleistocene.[8,9] Around Barkly West, within sediments associated with the Vaal River, several sites have been found. These include Canteen Kopje[8] (possibly Lower and Middle Pleistocene), Pniel 6[8] (Middle Pleistocene to Holocene) and Doornlaagte[8] (possibly Middle Pleistocene). Diamond mining at Delportshoop has revealed fossils and lithics, such as large handaxes of Acheulian origin (Fig. 2). At Rooidam and Biesiesput three localities have provided evidence for the Fauresmith industry.[8] Dating of Rooidam suggests a minimum age of about 200 kyr for these lithics.[9] On the Ghaap Plateau itself, rich open archaeological sites have been studied (such as Kathu Pan[8]). Moreover, caves in the foothills of the Kuruman Hills and Asbestos Mountains have been investigated. These include Wonderwerk Cave, which has provided a long but discontinuous record of Pleistocene archaeology, incorporating the Acheulian and Fauresmith.[8,10]

The main quarry tufas at Ulco, about

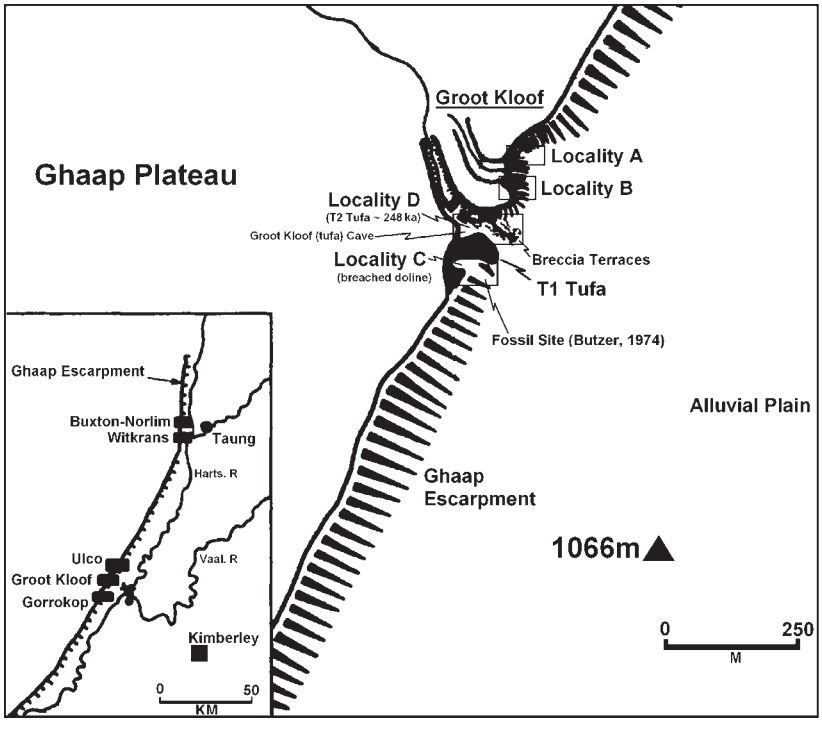

Fig. 1. Location of Groot Kloof within the escarpment of the Ghaap Plateau (modified from ref. 12).

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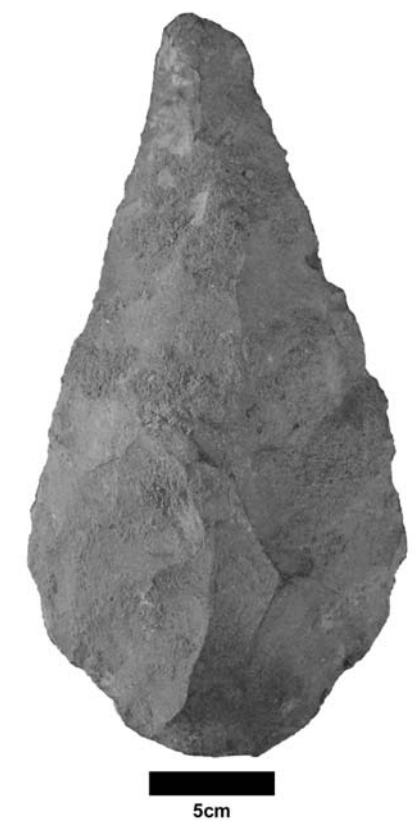

Fig. 2. Large Acheulian handaxe recovered from river deposits close to Delportshoop.

2.5 km northeast of Groot Kloof, were noted by Peabody,[2] who referred to them as Gaap. More recently, Marker[11] obtained a series of ^{14}C dates that are all infinite in age (older than 40 000 years BP). Groot Kloof was first studied by Butzer,[12–15] who suggested the tufa sequence there was primarily of Late Pleistocene age based on ^{14}C dating. It is noteworthy that Butzer[12] described only a small amount of fossiliferous and lithic-bearing breccia at Groot Kloof. He noted an absence of such deposits in the gorge itself, but found 'a small core and a Levallois flake of Middle Stone Age aspect,' in younger tufa below the breached doline (p. 374). Additionally, he described[12] a small number of fossils in a strongly eroded former fissure fill 'exposed on the footslope some 200 m south of Grootkloof' (p. 374). The area where Butzer observed these materials is marked as 'BFS' in our Fig. 3.

Here we describe for the first time extensive fossil and tool-bearing tufa and breccia at Groot Kloof. We present data from a field survey undertaken in 2004 and survey, surface collection and excavation during June–July 2005. We also provide the results of dating studies, faunal analysis and preliminary observations of lithics undertaken during 2005.

Geology

The Ghaap Plateau is a major exposure of the Campbell Subgroup rocks up to 1 500 m thick and covering about 80 000 km^2 along the western margin of the Kaapvaal craton in the Northern Cape and North West provinces.[16] The Campbell carbonates are deposited within the Griqualand West basin, being correlated with the Malmani Subgroup carbonates of the Transvaal basin. These carbonates contain early hominin palaeocaves such as found at Makapansgat and Sterkfontein. The Precambrian carbonate sequence of South Africa has undergone multi-phase karst development with the formation of palaeokarst, 'relict' karst and Quaternary karst in different areas. However, variation in structural disposition means that karst development in the Campbell Subgroup is very different from that within the Malmani Subgroup. The Campbell carbonates are underlain by Vryburg lava and Quartzite of the Campbell Subgroup and overlain by banded ironstone of the Kuruman Formation, Griquatown Subgroup.

Cave development is more limited due to the massive horizontal bedding of the dolomite and lack of major fracturing as seen in the rocks of the more deformed Malmani Subgroup. This is especially the case along the Ghaap escarpment. Large caves are generally limited to the foothills of the Kuruman Hills and Asbestos Mountains and include the relict, archaeological Wonderwerk Cave, the massive water-filled cavern of Bushmansgat, and smaller cave complex Kogelbeengrot. Small caves and rock shelters at Groot Kloof are associated with major bedding planes and eroded shale bands within the dolomite. In some instances, speleogenesis has occurred at the contact between the less soluble dolomite and more soluble tufa. At Groot Kloof, this process has resulted in the formation of a cave in the more ancient tufa. In other cases, streams have cut tufa edges resulting in the formation of undercut rock shelters. Rock shelters and caves have formed in the area through the dynamics of tufa formation, with small cavities emerging within the curtain-like structure of tufa carapaces and waterfalls. Many of these rockshelters have later been occupied by humans.

Site description and findings

The escarpment is well developed in the Ulco area, where relief is of the order of 100 m and a series of large tufa fans has developed. The largest is the Ulco tufa

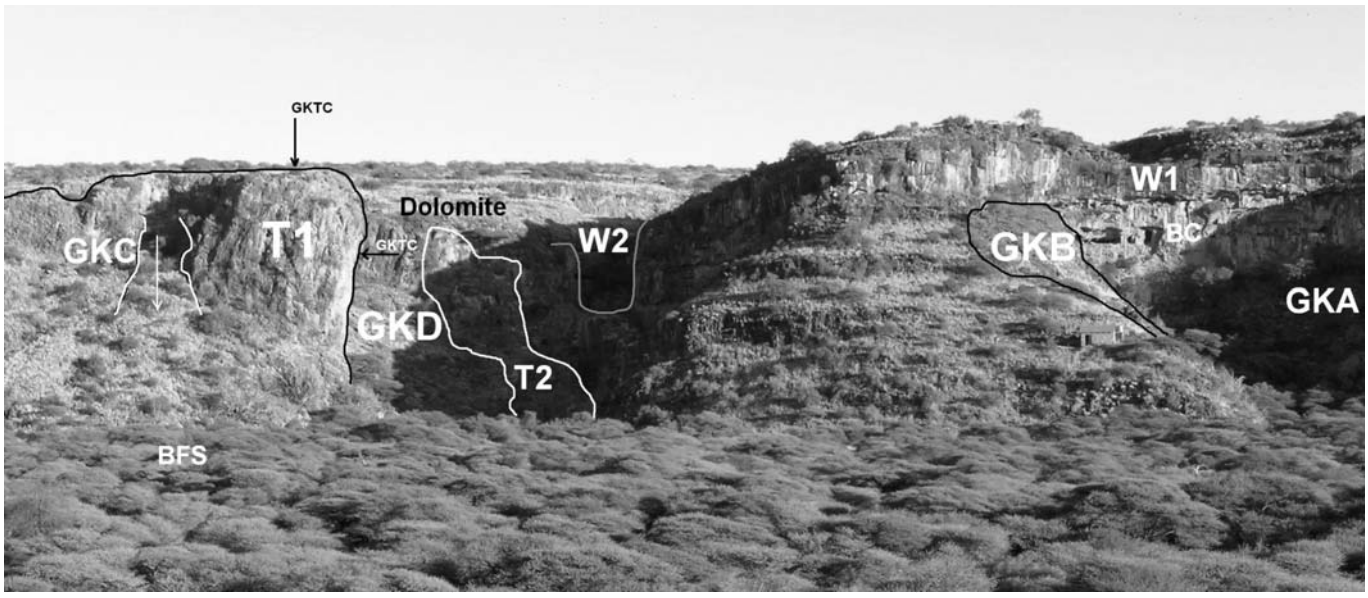

Fig. 3. Panoramic view of Groot Kloof indicating major features of the site (BC = baboon sleeping caves; see text for explanation of all other abbreviations).

currently mined by Holcim (Pty) Ltd. Around 5 km southwest of Ulco is the smaller tufa fan complex of Gorrokop, mined during the 1980s. Approximately equidistant between them is Groot Kloof, which has not been mined. In terms of its geomorphology, Groot Kloof (Fig. 1) differs from Ulco and Gorrokop because a series of deep gullies have been cut through the tufa and into the edge of the escarpment by waterfalls. At certain periods, large tufa flows (T1, T2: Fig. 1) have been deposited, and at other times these waterfalls (W1, W2: Fig. 1) have eroded the tufa and dolomite escarpment, forming breccias. Thus, a developmental cycle related to climatic and geomorphic cycles ranging from perhaps the Pliocene to Holocene has seen the formation and erosion of a series of deposits, some of them fossil and lithic-bearing.

We have defined four main localities at Groot Kloof (A–D) and their principal features are shown in Figs 1 and 3.

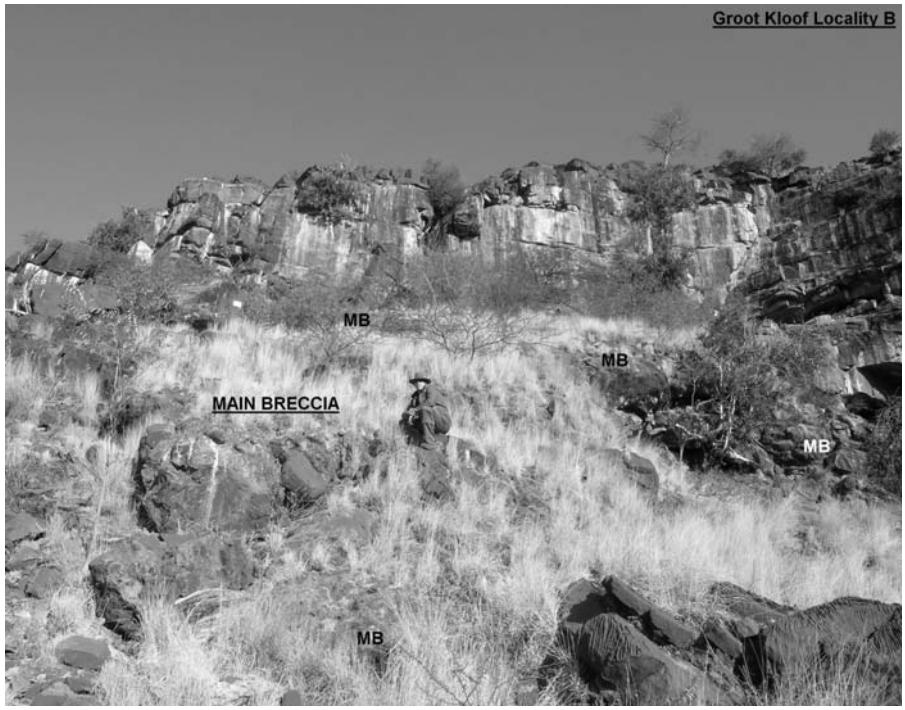

Fig. 4. Main breccia of GK-B.

GK-A

An extensive breccia mass occurring on the northernmost slope of Groot Kloof, being approximately 86 m in length (maximum) and more than 30 m in width. A slope containing fragmentary fossils (including an unidentified antelope horn core) and lithics has been located within surface exposures. This matrix-supported breccia occurs at an angle of more than 45° in places and represents a calcified gully fill associated with a small waterfall complex (W1). This breccia occurs on the opposite side of W1 to locality GK-B. Lower down the hill slope other calcified deposits occur that are related to calcification around a small spring that once issued from the base of a small cliff.

GK-B

This was the first exposure to be surveyed by us and contains a main breccia unit of about 110 m in length, at least 34 m in width, and thickness up to about 8 m (Figs 3, 4). This matrix-supported breccia occurs at an angle of up to 45° and also represents a calcified gully fill associated with W1. The northerly edge of the deposit has been eroded by the waterfall plunge pool and suggests an ancient age for the formation of the main breccia deposit.

The following fauna has been identified from GK-B following survey, surface collection and excavation: *Equus capensis* (giant extinct Cape plains zebra), *Equus* sp. (?plains zebra), *Damaliscus* sp. (medium-sized alcelaphine), *Kobus leche* (lechwe antelope) and *Homoioceras antiquus* (large-sized buffalo). These fauna belong to the Florisian Land Mammal Age and suggest a mid-Middle Pleistocene to Late Upper Pleistocene age for the main breccia.[17,18,32–35] The presence of the lechwe antelope suggests the existence of extensive wetlands in the area during or before the time of breccia formation. This is consistent with palaeoenvironmental studies in the region and elsewhere, which indicate that tufa formation usually occurs during major wet periods related to glacial and inter-glacial cycles.[12,14,15,19–22]

Stone tools from the main breccia include large, unifacial forms consistent with an Early Stone Age (ESA) industry (Fig. 5) and smaller forms more akin to the Middle Stone Age (MSA). Preliminary diagnosis suggests the presence of a transitional ESA to MSA industry, such as the Fauresmith, or a mixing of deposits of ESA and MSA age. Stone tools diagnostic of the Fauresmith Industry (such as small handaxes) occur in the open landscape around Groot Kloof, below the site and on the plateau above. The Fauresmith assemblage is dated in this region and in east Africa from about 154 kyr to around 350 kyr ago.[8,23–25]

Palaeomagnetic analyses undertaken on the main GK-B breccia have revealed a normal polarity. This suggests that stone tool deposition occurred within the last 780 kyr, consistent with findings from faunal and lithic analyses.

Other breccias occurring at GK-B were formed during more recent periods, having in-filled solutional tubes (Mokondos) and pockets that formed within the main GK-B breccia. These breccias contain a high density of small lithics (Fig. 6) suggestive of a Later Stone Age (LSA) industry. Other breccias contain shale washed out of shallow caves towards the base of the cliff. They contain small stone tools suggestive of an LSA assemblage.

GK-C

Locality C consists of a semi-circular

Fig. 5. Unifacial tool from the Main Breccia of GK-B.

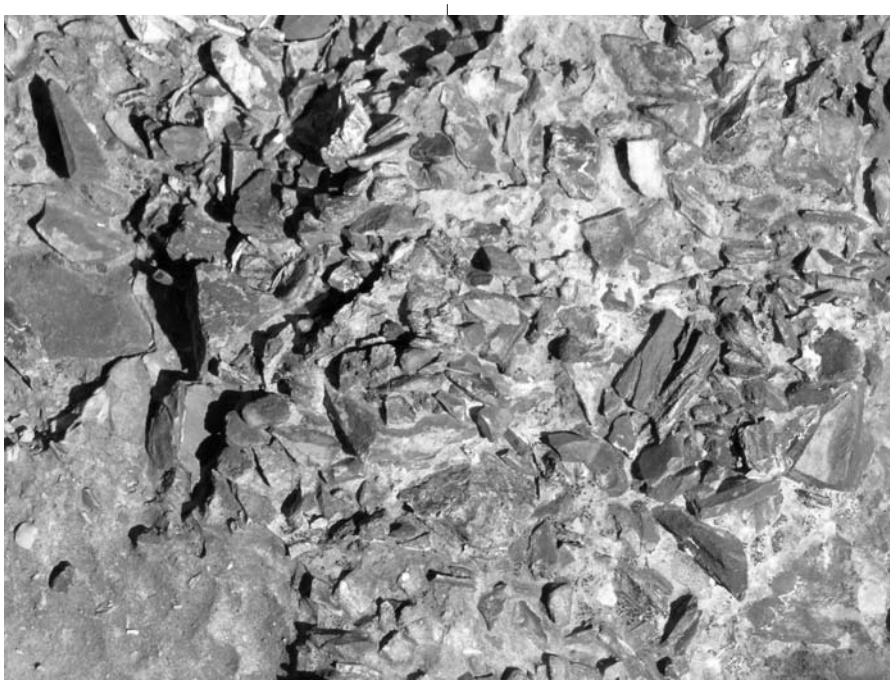

Fig. 6. Intrusive breccia containing a Late Stone Age industry. Note the high density of lithics.

breached doline within the T1 tufa of GK-D (Fig. 3). A small remnant cave occurs that contains speleothem, which appears to have formed when the cave was much more extensive, and prior collapse of the roof. Rock paintings are present in small rock shelters around the edge of this doline and stone tools and fossils cover a calcified talus cone that is around 50 m in length. We suggest that this occupation is associated with the most recent phase of erosion (Late Pleistocene–Holocene), but earlier occupation may also have occurred.

GK-D

Locality D (Fig. 3) covers the largest area of Groot Kloof and comprises multi-age deposits consisting of calcified terraces and surfaces, breccias, tufa, rock shelters and a large cave, the Groot Kloof Tufa Cave (GKTC: Fig. 3). Locality GK-D is the main gorge of Groot Kloof studied by Butzer:[12] apparently, he did not examine deposits classified by us as GK A–C.

The open site of GK-D comprises several areas:

1. T1 is the most extensive tufa at Groot Kloof and appears to be the most ancient. It comprises a steeply dipping waterfall tufa, heavily altered and eroded.
2. Tufa 2 (T2: Fig. 3) has formed within the erosion gully created by the Groot Kloof waterfall (W2: Fig. 3). It is also a steeply dipping waterfall tufa that has been heavily eroded by a large plunge pool formed by W2. Macro- and micro-fauna have been located *in situ* high up in the tufa, though not yet excavated. The tufa also sits above (on top of) a breccia mass that contains *in situ* micro-faunal fossils and as yet undescribed lithics. This situation is unusual as the fossils are encased directly within the tufa rather than being part of the fill of small cavities as at Taung and other sites along the escarpment. This has allowed direct dating of the fossil deposits. We have obtained a preliminary U–Th date of 248 ± 37 kyr ago for microfauna-bearing deposits of the T2 tufa. Adjacent to this is macrofauna-bearing tufa. Palaeomagnetic analyses undertaken at the same section have revealed a normal polarity, consistent with deposition within the last 780 kyr.
3. A series of Late Upper Pleistocene and Holocene tufa flows have also formed at the current lip W2, on cliff faces and blanketing the much older tufa in some areas. These were studied and dated using the ^{14}C method by Butzer.[12]
4. A series of calcified terraces were eroded by the down cutting of the river. Some of this breccia appears to be of Middle Pleistocene or pre-Middle Pleistocene age as it underlies T2. This breccia is fossil and lithic-bearing, but fossils are fragmentary. Other sections of these calcified terraces also contain stone tools (presently unidentified).
5. GKTC (Fig. 3) is a small, multi-entrance cave formed within T1. Three entrances occur on the eroded top of T1. One entrance opens out onto a large talus slope developed along the main gully formed by the W2 waterfall. The cave contains a breccia floor and extensive speleothem deposits.
6. At GK-D, a series of rock shelters occurs on the edge of the large talus slope originating at the entrance to GKTC. These rock shelters are eroded into T1 and range from large, relatively open shelters to small low caves. All of these shelters contain rock art similar to that found at GK-C, implying recent occupation.

Significance

A late-Middle Pleistocene date (248 ± 37 kyr) for the fossil-bearing section of T2 at Groot Kloof shows it to be contemporaneous with several important palaeoanthropological sites in South Africa. These include the Oxland Tufa at Taung (256 ± 21 kyr),[22] containing Equus Cave, the oldest layers at Florisbad, including the hominin cranium (259 ± 35 kyr),[26] perhaps Rooidam,[8] probably sections of Wonderwerk Cave,[8,10] and the Cave of Hearths.[27,28] This period of human evolution is poorly understood, yet vital to understanding the emergence of modern humans.[25,29–31] The existence of extensive fossil-bearing deposits is rare across South Africa, especially in the Northern Cape province. The fact that tufa and breccia at Groot Kloof have not been mined or subjected to previous archaeological excavation underscores the unique nature and potential of our discovery.

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