The First Report of an Archosaur from the Kayenta Formation of Washington County, Utah

Robert Gay[1], Andrew R. C. Milner[2]

1. Mission Heights Preparatory High School, 1376 E. Cottonwood Lane, Casa Grande, Az. 85122.
928-660-9711
rob.gay@leonagroup.com
2. St. George Dinosaur Discovery Site at Johnson Farm, 2180 East Riverside Drive, St. George, UT 84790,
(435) 574-3466, ext. 2
arcmilner@gmail.com

ABSTRACT - The Kayenta Formation has yielded numerous tetrapod fossils, including, amphibians, theropods, prosauropods, ornithischians, crocodylomorphs, sphenodonts, tritylodonts, pterosaurs, turtles, and rare mammals. Despite the phylogenetic diversity of the preserved animals, virtually all of the vertebrate fossils have come from the Ward Terrace area of north-central Arizona, on the Navajo Nation Reservation. Here we describe the first remains of a tetrapod found in the Kayenta Formation of Washington County, Utah. Tetrapod body fossils from the Kayenta Formation in southwestern Utah are proving to be very rare however, in contrast to common vertebrate tracks. The specimen described herein is likely the remains of a sphenosuchian crocodylomorph.

INTRODUCTION

The Early Jurassic (Sinemurian) Kayenta Formation has been well studied and explored since at least the 1940s (Welles, 1954), and has yielded a diverse tetrapod vertebrate fauna. The majority of exposures surveyed are on the Navajo Nation in north-central Arizona. The area around Gold Tooth Springs and Rock Head especially have been very productive (Rowe, 1989; Sues, 1986; Clark and Sues, 2002), but few body fossils have been reported from out of this region (Kermack, 1982). In contrast, footprints are common throughout the formation with several localities described (e.g., Lockley and Gierliński, 2006; Hamblin and others, 2006; Lockley and others, 2006; Milner and others, 2012), however many tracksites still remain unstudied at this time. Here we describe the first remains of an associated tetrapod skeleton found in the Kayenta Formation of Washington County, Utah.

In October 2011 the authors discovered fragmentary vertebrate remains in the lowermost “silty facies” of the Kayenta Formation in Warner Valley, southeast of St. George (Figure 1). The fossils were immediately recognized as belong to a tetrapod and were of significance due to the lack of documented body fossils from the Kayenta Formation in southwestern Utah. Initial study of the specimen revealed traits that linked it to other Late

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Triassic and Early Jurassic clades of archosaurs. The decision was made in 2012 to reexamine the site for more remains using hand searches as well as screening for fragments. The site was reexamined again in 2013 and additional fragments were recovered which allow us to refine our assessment of this specimen.

MATERIALS AND METHODS

The fossils used in this study are accessioned at the Natural History Museum of Utah (UMNH) and will be curated there in perpetuity. Specimens were collected under Bureau of Land Management permit number UT09-022-SW issued to the second author. Standard field paleontology surface collection techniques were employed in the recovery of UMNH VP 21923. A 1.5 m square grid was laid on the outcrop and systematically sampled by hand and by using a 1 mm dry screen. Bones were examined and photographed at the St. George Dinosaur Discovery Site at Johnson Farm (SGDS). Fragments that could be reassembled were repaired using either acryloid B-72 adhesive or PaleoBond PALEO-POXY™, depending on the size of the area to be attached.

GEOLOGICAL SETTING

The Kayenta Formation in the Warner Valley area of Washington County is divided into three units: the Springdale Sandstone Member at the base (braided stream system); the informally named, slope-forming "silty facies" (fluvial channels, playa, and transgressive/regressive lacustrine units); and the upper "Kayenta-Navajo Transition" (transition from fluvial playa into eolian deposits).

The Springdale Sandstone Member of the Kayenta Formation is unconformably underlain by the lacustrine Whitmore Point Member of the Moenave Formation. In southwestern Utah and northwestern Arizona, the J-0' unconformity (Marzolf, 1993; also known as the J-sub-Kay unconformity (Riggs and Blakey, 1993)) is located between the Moenave and Kayenta formations. The lower Kayenta Formation exhibits few gypsum deposits while the middle section has relatively more abundant deposits of gypsum, but has so far yielded no fossil remains. The upper portion of the section was not surveyed or prospected for this project.

The "silty facies" is composed mainly of silty mudstone and sandstone deposits with occasional limestone beds representing ephemeral lakes, and sheets of carbonate-rich sandstones often with dinosaur tracks on their upper surfaces (Lockley and others, 2006; Hamblin and others, 2006; Milner and Spears, 2007; Milner and others, 2012). This corresponds well with the "silty facies" of the Kayenta Formation from the Ward Terrace region in north-central Arizona as reported by previous workers (Baker, 1936; Peterson and Pipiringos, 1979).

The locality, 42Ws502V (Field Number AM-11-35), also referred to as the "Jack Site", is located about 6 m above the contact between the Springdale Sandstone Member and the 'silty facies' of the Kayenta Formation. The locality is approximately 2 m below a carbonate-rich sandstone bed which preserved abundant *Eubrontes*-like theropod dinosaur tracks. Fish fossils (semionotids, palaeoniscoids, and coelacanths) have been discovered locally in large quantities from a thin limestone bed ("Sarah's Fish Bed"; Milner and others, 2012) about 1 m above the top of the Springdale Sandstone Member and approximately 5 m below the Jack Site (Figure 2). To-date, these are the only reported vertebrate remains thus far reported from the Kayenta Formation in Warner Valley. Although other sites are known, the remains are rare, fragmentary, and often unidentifiable. The presence of limestone beds, fish fossils, stromatolites, conchostracans, and ostracods in the lower part of the "silty facies" supports an interpretation of a shallow lake environment (Milner and others, 2012). With increased aridity to the area, the return of fluvial systems increased higher in the "silty facies", along with saline playas, and eventually eolian deposition in the upper part of the Kayenta Formation with the migration of the Navajo erg (Milner and others, 2012).

DESCRIPTION

UMNH VP 21923 likely represents a single organism that is fragmentary. The fragments that have been recovered are not duplicated insofar as can be determined. Using the largest preserved centrum (discussed below), no element is significantly larger or smaller than what would be expected from a single individual. All recovered elements appear consistent with a single taxon as well. The sparse nature of vertebrate body fossils preserved in the Kayenta Formation at Warner Valley further supports this conclusion, and the formation has been extensively prospected to the east of the Jack Site for 8 years with very rare and fragmentary tetrapod fossils being recovered.

Preservation

All of the recovered elements have been broken post-burial to some degree. All of the dorsal vertebral centra have been fractured vertically (usually at the midpoint) although one is broken transversely as well as having both articular ends missing. The cervical centrum is well worn due to weathering. The osteoderms and skull fragments are not preserved as complete elements. Bone preservation appears good to very good in this specimen with large portions of cortical bone remaining intact in virtually every element. The bone is preserved with a grey to white coloration on unbroken surfaces. Details <0.5 mm remain clearly visible on ornamented surfaces such as skull elements and osteoderms. The osteoderms and skull elements have a thin red iron mineral crust on some surfaces, similar to what has been reported from the Kayenta Formation in other localities (Colbert, 1981). Owing to the fine preservation and tough nature of the mineral crust, it has not been prepared off of the bone surface nor has its composition been analyzed at the time of publication. While this crust does obscure some surface features it does not prohibit identification of elements or features on their surfaces. The bone is generally not friable and relatively hard. The elements were found as loose clasts on the surface, and likely most of the animal has eroded away.

Differential Diagnosis

While no unambiguous autapomorphies are recognized in UMNH VP 21923, it can be distinguished from other armored taxa in the Kayenta Formation. From the Kayenta '*Scelidosaurus'* (Padian, 1989): armor morphology in *Scelidosaurus* differs significantly from UMNH VP 21923. *Scelidosaurus* possesses multiple conical osteoderms with distinct depressions on their ventral surface (Padian, 1989). Other osteoderms are keeled in *Scelidosaurus* with a distinct ventral concavity. Ornamentation on conical osteoderms is absent and not complex on the keeled osteoderms of *Scelidosaurus*. UMNH VP 21923 has none of these characters. In addition, the specimens referred to as *Scelidosaurus* from the Kayenta Formation are an order of magnitude larger than UMNH VP 21923.

From *Scutellosaurus lawleri* (Colbert, 1981): the cervical vertebrae are longer and narrower in *S. lawleri.* The dorsolateral excavations on the cervical centrum are shallower in *S. lawleri* compared with UMNH VP 21923. UMNH VP 21923 preserves deep neural canal excavations in the dorsal vertebrae while *S. lawleri* does not possess deeply excavated neural canals. The osteoderms of *S. lawleri* have multiple morphologies with ventral excavations and random pitting. In UMNH VP 21923 two distinct morphologies have been identified (flat and bent), but no osteoderm is preserved intact. This makes identification of true osteoderm morphology difficult. None of the osteoderms in UMNH VP 21923 preserve a ventral concavity. From MNA V.3133, identified as *Scutellosaurus* sp. (Gay, 2013), as in *S. lawleri*, *Scutellosaurus* sp. has shallow neural canals on the dorsal centra and UMNH VP 21923 does not. MNA V.3133 lacks the ventral concavity of *S. lawleri*, as does UMNH VP 21923. The vertebrae, however, are dissimilar in having neural canals. UMNH VP 21923 cannot be assign to either *S. lawleri* or *Scutellosaurus* sp.

From the turtle, *Kayentachelys aprix* (Gaffney and others, 1987), plastron and carapace segments are unornamented and thicker compared to UMNH VP 21923. There is no evidence of a plastron or carapace in UMNH VP 21923 as the osteoderms are much smaller than *K. aprix* shell pieces examined by the senior author at MNA. The dorsal centra in turtles are fused to the carapace; they are not fused to any osteoderms in UMNH VP 21923.

From *Eopneumatosuchus colberti* (Crompton and Smith, 1980; Curtis and Padian, 1999): While Crompton and Smith (1980) did not describe or figure any osteoderms from *Eopneumatosuchus*, Curtis and Padian (1999) suggested that several osteoderms recovered from screening the *Eopneumatosuchus* type locality may belong to that genus. These are described as either flat plate-like osteoderms or leaf-/spade-shaped osteoderms. Both morphologies have surface ornamentation or pitting similar to what is seen in UMNH VP 21923. Curtis and Padian (1999) also mention that the recovered osteoderms resemble those of *Protosuchus* from the slightly older Moenave Formation which is discussed below. At this time the figured armor referred to *Eopneumatosuchus* does not match the armor morphologies preserved in UMNH VP 21923.

It is possible that UMNH VP 21923 represents an animal not previously reported from the Kayenta Formation, or one that is known but preserves no post cranial skeleton (e.g., *Calsoyasuchus valliceps* (Tykoski and others, 2002)) . As such UMNH VP 21923 is compared to known organisms in order to eliminate them as possible taxa or relatives. From *Chasmatosaurus rossicus* (Ezcurra and others, 2013), the cervical vertebrae are more elongate, the diapophysis and parapophysis are on cranial half of centrum, and the ventral keel is less pronounced. From *Nundasuchus songeaensis* (Nesbitt et al., 2014): diapophyses less pronounced, osteoderms less ornamented, lacking deep grooves on external surfaces, no obvious caudal thinning or articular facet. From *Prolacerta broomi* (Parrington, 1935; Gow, 1975): by possessing osteoderms, cervical vertebra craniocaudally compressed, possessing a pronounced ventral keel. From *Youngina capensis* (Gow, 1975): dermal osteoderms are large with a lateral bend, likely paired. These taxa are generally Late Triassic in age and the temporal and morphological distance between them and UMNH VP 21923 serves to eliminate them as candidates.

The most obvious animal to compare UMNH VP 21923 with outside of the Kayenta Formation is *Protosuchus richardsoni* (Colbert and Mook, 1951). *Protosuchus richardsoni* is known from the slightly older Dinosaur Canyon Member of the Moenave Formation which underlays the Kayenta Formation unconformably in the Ward Terrace region of Arizona. In addition, several specimens of at least two undescribed taxa similar to *Protosuchus* have been found in the Kayenta Formation in Arizona (Sues and others, 1994). A comparison with the published photographs of *Protosuchus* showed very different armor morphologies. The armor of *Protosuchus* tends to be flat and square with ornamented surfaces. Photos of UCMP 125358, the *Edentosuchus*-like protosuchid, show a similar square morphology. At least in *Protosuchus* this morphology is consistent across the dorsum of the body. In the *Edentosuchus*-like form no additional information about the armor morphology is published. The cervical vertebrae of UNMH VP 21923 are similar to both *Protosuchus* and the *Edentosuchus*-like forms, which indicate that UMNH VP 21923 may be closely related despite the differences in the armor.

Preserved Elements

UMNH VP 21923 comprises three skull fragments (Figures 3-5), one cervical centrum, lacking neural arch or processes (Figure 6), two complete and two incomplete proximal dorsal centra (Figures 7-10), one neural arch or process fragments (Figure 11), a possible tooth fragment (Figure 12), six partial osteoderms (Figures 13-16), and several small unidentified bone fragments (Figure 16). Each identifiable element is described in detail below.

Skull Fragment A

Skull fragment A was recovered in two pieces and repaired (Figure 3). The total length of 2 cm for the preserved portion of the element is recorded though broken ends make life length estimates difficult. The element is delta-shaped in cross-section with two concave sides. Faint ornamentation in the form of shallow random pits is present on the flat surface of the bone. The cortical bone is well preserved but mostly covered in mineral crust that could not be prepared off. This element is tentatively identified as a quadrate process based on the shape (long and relatively thin), coupled with ornamentation on the exterior surface and a possible articular surface on the medial surface.

Skull Fragment B

Skull fragment B is a complex element, possibly representing the medial portion of the postorbital (Allen, 2010, figure 3.6) as it preserves the classic crocodylomorph triradiate structure (Figure 4). While we have identified this as a skull bone based largely on its asymmetry it may also represent a portion of a neural process. This element measures 1.3 cm by 1.2 cm and has suffered post-burial breakage. Despite the damage most of the cortical bone is intact on this element and in good condition.

Skull Fragment C

This large (2.8 cm x 1.6 cm) bone fragment is tentatively identified as a skull bone, possibly a portion of the occipital, on the basis of its size, a possible suture, and a distinct endocast (Figure 5). Orientation of this element is difficult to determine as the item has been broken in multiple locations. A thin area of cortical bone appears to remain on the convex surface opposite the endocast. The bone is highly vascularized around the endocast, decreasing towards the cortical margin. A dark black line runs across the cortical surface of the bone. At the broken surface the black line runs diagonally at a 45^{o} angle towards the endocast. This black line appears to divide the bone on the broken surface. We hypothesize that this line represents a suture. Examinations of CT data of *Alligator mississippiensis* (TMM M-983; Rowe and others, 2003) using inspeCTor, shows similarities between the occipital of *A. mississippiensis* and UMNH VP 21923.

Tooth Fragment

This element is tentatively identified as a tooth fragment on the basis of what appears to be enamel on the exterior surface of the element (Figure 6). No additional dental material has been recovered.

Cervical Vertebra

This single cervical vertebra is 1.4 cm in length and 1.2 cm laterally at the widest point. No neural spine or associated processes are preserved (Figure 7). The articular surfaces are amphicoelous. It is obvious that a prominent ventral keel existed on the centrum with dorsolateral excavations on either side. These excavations are present in the body of the centrum and constrict the keel to a maximum lateral width of 2 mm. These excavations are deepest at the cranial edge of the vertebra and decrease towards the caudal margin. The parapophyses and diapophyses have been mostly lost to erosion, although their roots remain clearly on the right surface of the vertebra. On the right side, the parapophyses are present in the cranial half of the centrum and are thick (3.5 mm dorsoventral height). A shallow lateral depression into the body of the centrum separates the parapophysis from the diapophysis. The diapophyses are present only on the caudal half of the centrum and are 1.5 mm thick dorsoventrally.

Dorsal Vertebra A

Dorsal vertebra A was found broken transversely at the midpoint of the vertebra and was repaired (Figure 8). The vertebra is 2.5 cm in length and constricted both laterally and dorsally. The articular surfaces are amphicoelous and roughly circular (1.5 cm by 1.7 cm). The cortical bone around the articular surfaces has been worn away. This may make the articular surfaces appear rounder than they were *in vivo*. Diapophyses and parapophyses are not present on the vertebra. The neurocentral sutures are heavily worn so no conclusions can be drawn about suture fusion. The neural canal is deeply entrenched into the centrum with a maximum depth of 5 mm below the area of the neurocentral suture. The centrum itself is laterally and dorsally compressed with the body of the centrum being hollow.

Dorsal Vertebra B

Dorsal vertebra B has been damaged heavily due to weathering (Figure 9). In addition to a transverse mid-centrum break, the anterior articular surface has been completely weathered away. The two fragments were reassembled along the fracture with minor reconstruction. The centrum has a length of 2.7 cm. Cortical bone is only preserved on the lateral and dorsal sides of the centrum. The presumed caudal portion has an intact articular surface and the base of the diapophysis is preserved on the right lateral side. The neurocentral suture region is worn down below the suture line and no evidence of a diapophysis or parapophysis is present. The preserved caudal articular surface measures 2 cm dorsoarticular surface dorsoventrally and 1.4 cm laterally. The neural canal is obscured by matrix which has not yet been prepared away. Before reassembling the two fragments the profile of the neural canal was noted to be deeply incised into the centrum, similar to the other preserved dorsal vertebrae. As in dorsal vertebra A, the centrum is constricted dorsally and laterally compressed, at least where the vertebra was transversely fractured the body of the centrum was hollow.

Dorsal Vertebra C

Dorsal vertebra C is half of a dorsal centrum (Figure 10). It shares many characteristics with the previously described two centra: the neural canal is deeply excavated into the centrum, the body of the centrum is hollow, the neurocentral sutures and articular surface are worn, the centrum is laterally and dorsally compressed, and cortical bone is present along most of the lateral and dorsal surfaces of the vertebra. The preserved articular surface is 1.1 cm x 1.2 cm across. No matching fragment was found at the site to complete the centrum so the length of the centrum is unknown, though based on preserved morphology it was likely similar to the two complete centra recovered. No parapophyses or diapophyses are preserved on this centrum.

Dorsal Vertebra D

The identification of this element as a dorsal vertebra fragment is less certain as it preserves no neurocentral sutures, articular surfaces, or neural canal (Figure 11). This element is tentatively identified as a dorsal centrum based on the curvature of the presumed ventral surface. This element, lacking any other diagnostic features that can identify its origin, is not used in the following analyses.

Neural Arch Fragment

One fragment of a neural arch was recovered from the site. Only the bases of the processes remain making it difficult to state much more about its features (Figure 12). It appears to have been fractured vertically. No articular surfaces remain intact though the cortical bone is well preserved on this element.

Osteoderms

The presence of osteoderms in UMNH VP 21923 was an important clue in ruling out many possible taxa previously known from the Kayenta Formation. Two large, flat, incomplete osteoderms were recovered (Figure 13), closely resembling the cervical paramedial osteoderms of archosaurs such as *Protosuchus* (Colbert and Mook, 1951) and *Hesperosuchus* (Allen, 2010). These presumed cervical paramedian osteoderms are large but incomplete. A mineralized crust does obscure some features especially on the largest osteoderms (Figures 13–16), but the cortical surface is well exposed allowing a description of the elements. The dorsal surfaces of the osteoderms are ornamented with shallow random pits. The ventral surface has shallow linear marks trending along the preserved long axis of the bone. No immediate corollaries to these linear marks are known from other Late Triassic or Early Jurassic armored archosauriforms, due to most specimens being preserved articulated with their vertebral column, and therefore not prepared off of the body.

Two arched osteoderms were also recovered (Figure 14). In cross-section (Figures 15, 16) the arched nature of the osteoderms is obvious. The angle of the bend on the ventral surface of the osteoderms is not symmetrical. One of the medial faces is at 137^{o} to the midline while the other is at 127^{o}. The divergent angles and ventral concavity implies that this is not a median ridge as is found in some armored dinosaurs (Colbert, 1981), phytosaurs (Stocker and Butler, 2013), and “rauisuchians” (Nesbitt and others, 2013), but is a distinct lateral bend. This lateral bend is found in some archosauriforms (Ezcurra and others, 2013) and archosauromorphs. Pseudosuchians like aetosaurs (though they can also possess medial ridge) (Desojo and others, 2013) and crocodylomorphs also possess this lateral bend in their osteoderms. In this regard the preserved morphology osteoderms conform very well to the dorsal paramedian osteoderms of archosaurs such as *Dromicosuchus* (Allen, 2010). Virtually all of these armored taxa come from older (Olenekian-Hettangian) deposits and thus are not directly comparable to UMNH VP 21923. The exceptions to this are that crocodylomorphs which are known from younger rocks, including the Kayenta Formation. Unfortunately, many either lack preserved osteoderms (*Calsoyasuchus,* Tykoski and others, 2002; *Kayentasuchus,* Clark and Sues, 2002) or have not been described (*Protosuchus*-like and *Edentosuchus*-like forms; Sues and others 1994).

DISCUSSION

The Kayenta Formation has a relatively well-known fauna from the core area (approximately the middle of the preserved depositional area, near the main fluvial deposition system). Knowledge of the fauna outside of this area, preserved on the Navajo Nation, has been sparse and not well studied. UMNH VP 21923 is the first glimpse of the communities present outside of the Gold Spring and Rock Head areas. New discoveries in the Kayenta Formation of Washington County by one of the authors (AM) indicate that not only does UMNH VP 21923 represent the first known archosaur in Washington County, but that a new and possibly distinct fauna existed in the Washington County area during Kayenta times. UMNH VP 21923 is frustratingly incomplete but does provide the first documented window into the fauna of the Kayenta Formation in Washington County.

UMNH VP 21923 is clearly differentiated from the armored dinosaurs known from the Kayenta Formation on the basis of its armor morphology. It is also distinct from the slightly older *Protosuchus*, known from the Late Triassic-Early Jurassic Moenave Formation on the basis of the presence of flat, unarched dermal armor. The armor morphology most closely matches that of sphenosuchians such as *Terrestrisuchus*. A sphenosuchian, *Kayentasuchus*, is known from cranial remains from the Kayenta Formation on the Navajo Nation. No overlapping material exists to allow a direct comparison between the type of *Kayentasuchus* (UCMP 131830; Clark and Sues 2002) and UMNH VP 21923. It is likely that UMNH VP 21923 represents a sphenosuchian crocodylomorph, possibly *Kayentasuchus*. Considering the incomplete nature of the remains of this organism, it is possible that an undiagnosed sphenosuchian crocodylomorph is represented by UMNH VP 21923. Given the lack of phylogenetic information preserved, the lack of autapomorphies, and the lack of overlapping material between *Kayentasuchus* and UMNH VP 21923, it would not be wise to refer this specimen to any established taxon at this time. Further investigations in the Kayenta Formation of Washington County have yielded additional vertebrate remains (small and large theropods, ornithischians (?), and crocodylomorphs all based on teeth). Allowing natural weathering to occur and reexamining the Jack Site may allow further refinement as to the identity and phylogenetic position of UMNH VP 21923.

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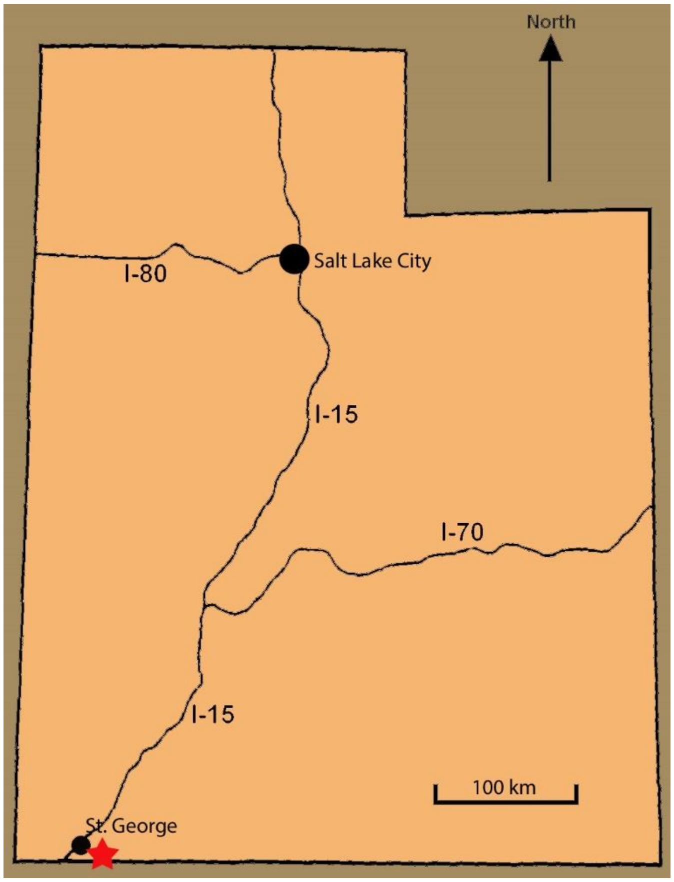

Figure 1: Location of Warner Valley within the state of Utah.

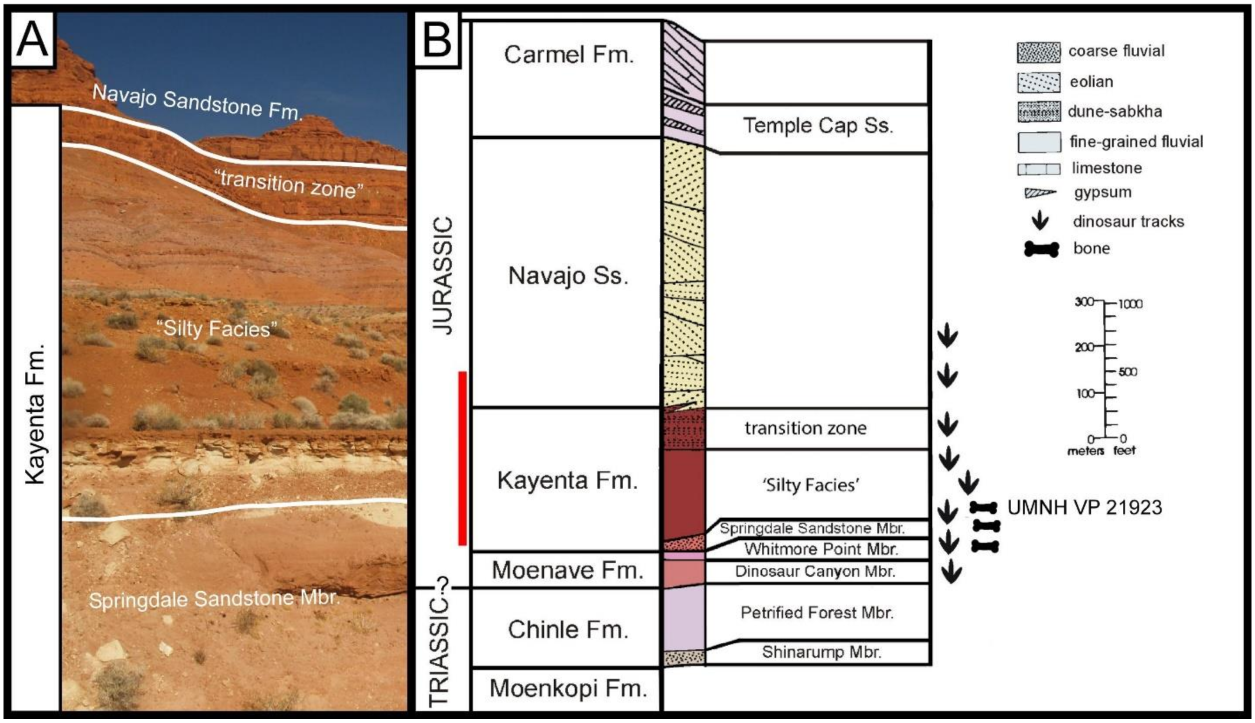

Figure 2: Overview of the geology of Warner Valley, showing the stratigraphic location of UMNH VP 21923 within the 'Silty Facies' of the lower Kayenta Formation.

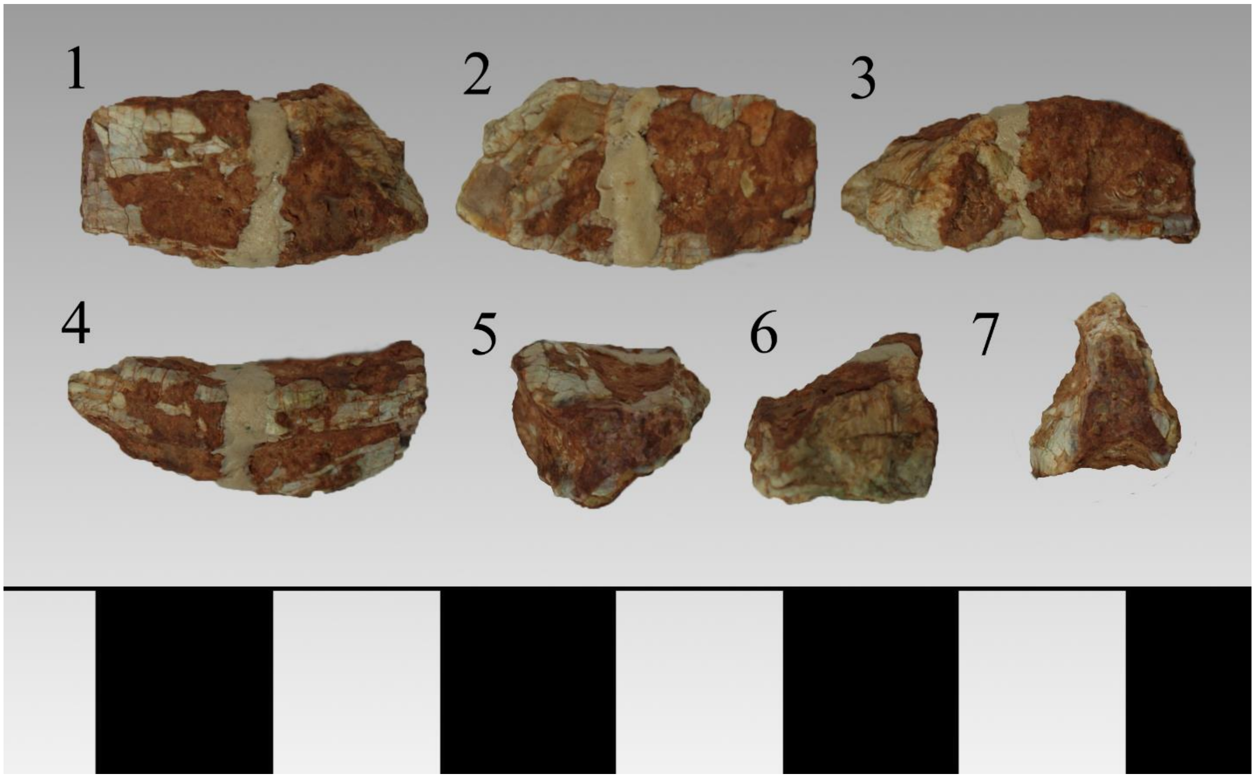

Figure 3: Skull Fragment A, possible quadrate in 1) medial, 2) lateral, 3) ?posterior 4) ?anterior, 5-7) cross-section views. Scale: 1 box = 1 cm.

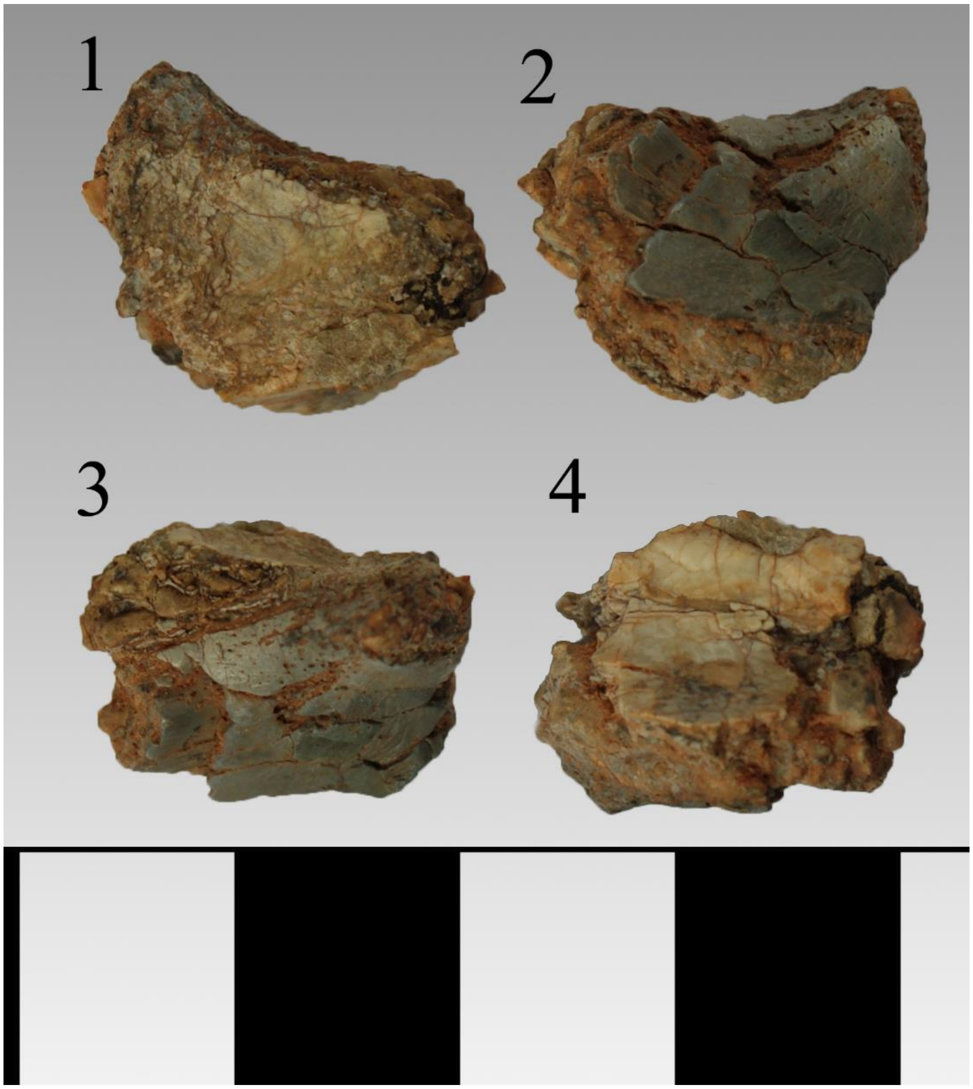

Figure 4: Skull Fragment B, possible postorbital in 1) dorsal, 2) ventral, 3) lateral, 4) medial views. Scale: 1 box = 1 cm.

Figure 5: Skull Fragment C, possible occipital in 1) posterior, 2) anterior, 3) dorsal, 4) ventral views. Scale: 1 box = 1 cm.

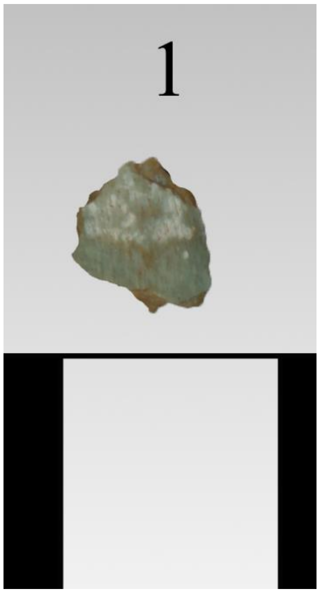

Figure 6: Tooth Fragment. Scale: 1 box = 1 cm.

Figure 7: Cervical vertebra in 1) anterior, 2) dorsal, 3) right lateral, 4) ventral, 5) left lateral, 6) posterior views. Scale: 1 box = 1 cm.

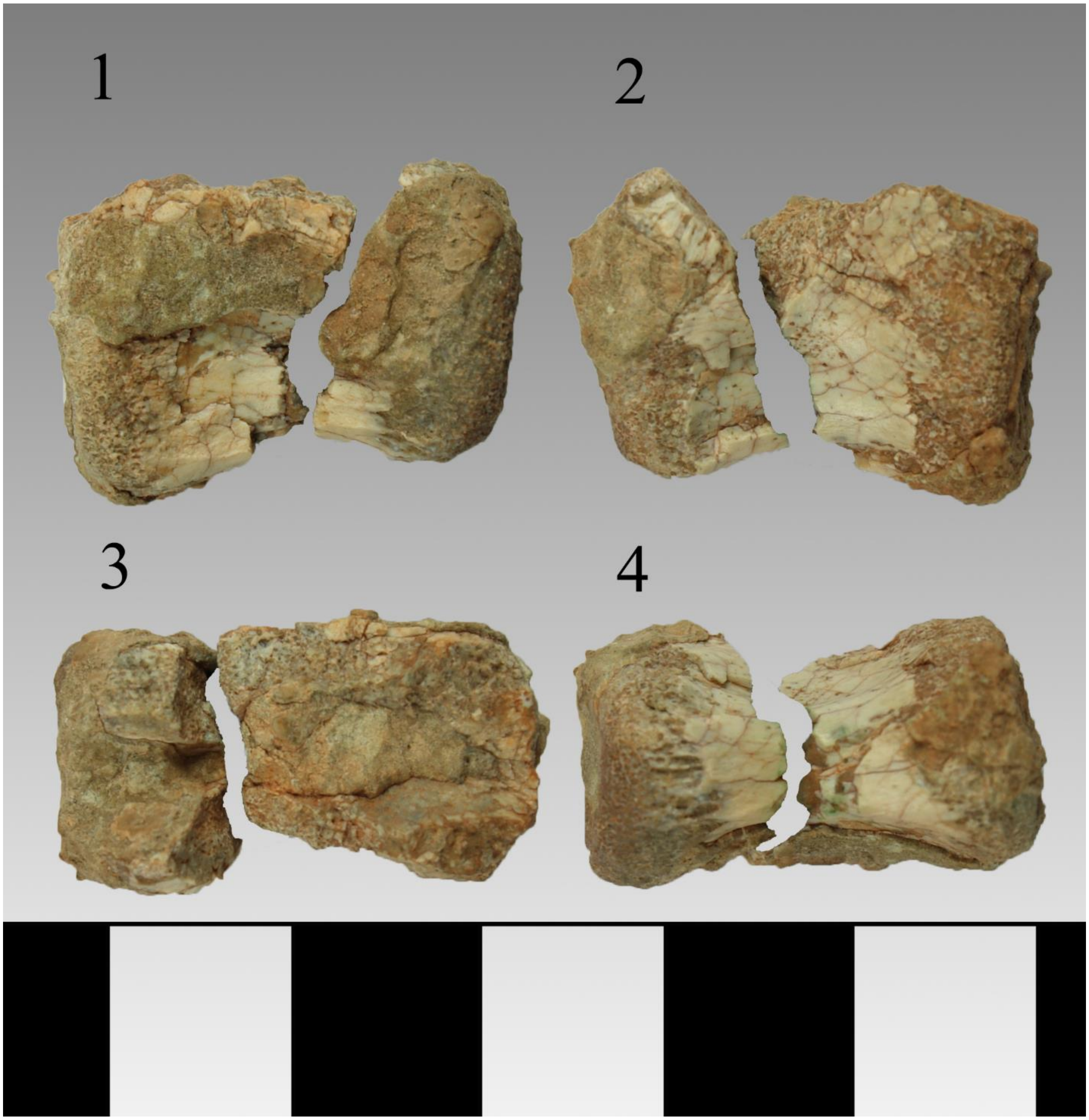

Figure 8: Dorsal Vertebra A in 1) right lateral, 2) left lateral, 3) dorsal, 4) ventral views. Clay support/reconstruction digitally removed. Scale: 1 box = 1 cm.

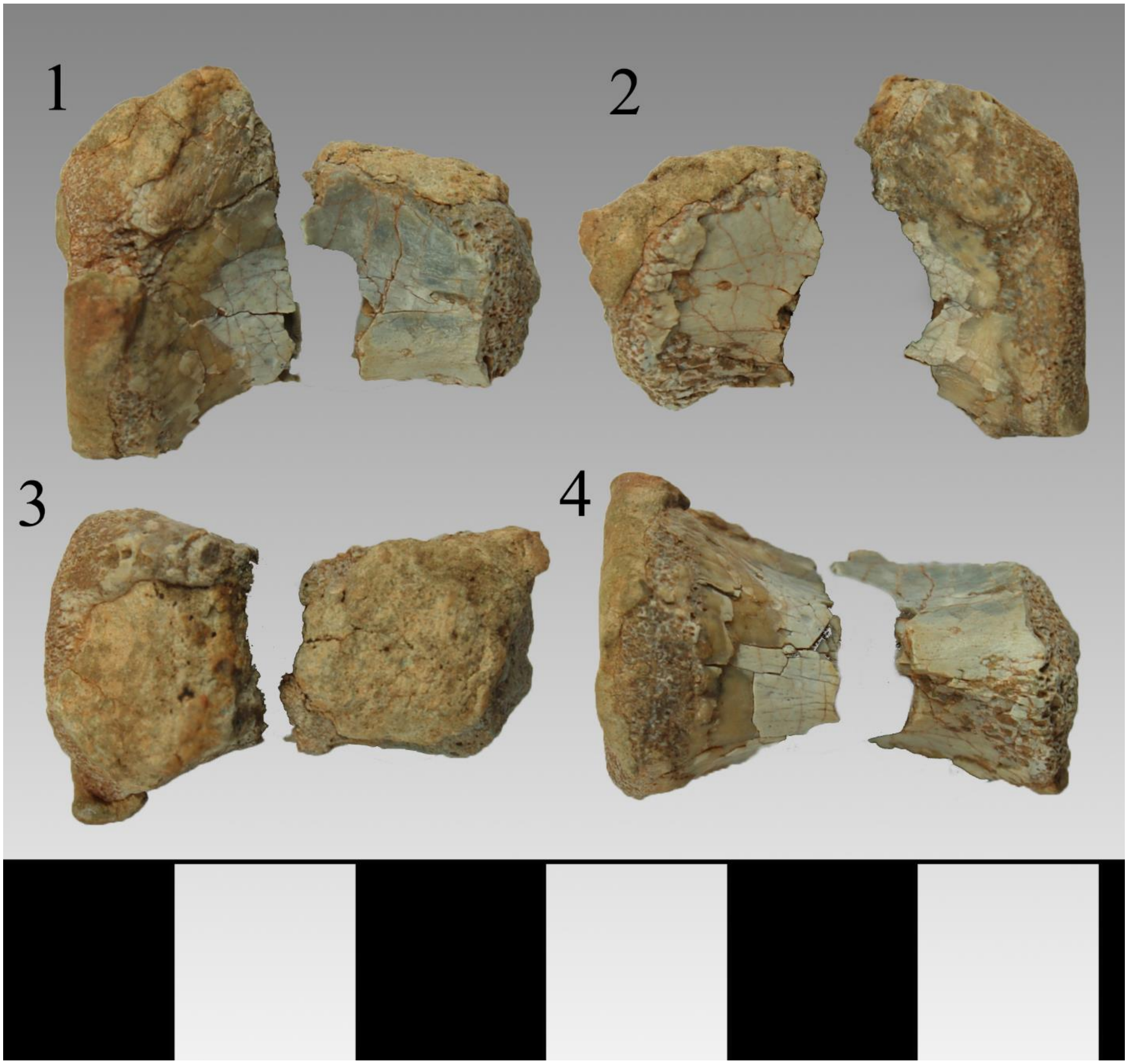

Figure 9: Dorsal Vertebra B in 1) right lateral, 2) left lateral, 3) dorsal, 4) ventral views. Clay support/reconstruction digitally removed. Scale: 1 box = 1 cm.

Figure 10: Dorsal Vertebra C in 1) ?right lateral, 2) articular, 3) ?left lateral, 4) transverse, 5) dorsal, 6) ventral views. Scale: 1 box = 1 cm.

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Figure 11: Dorsal Vertebra D in lateral view. Scale: 1 box = 1 cm.

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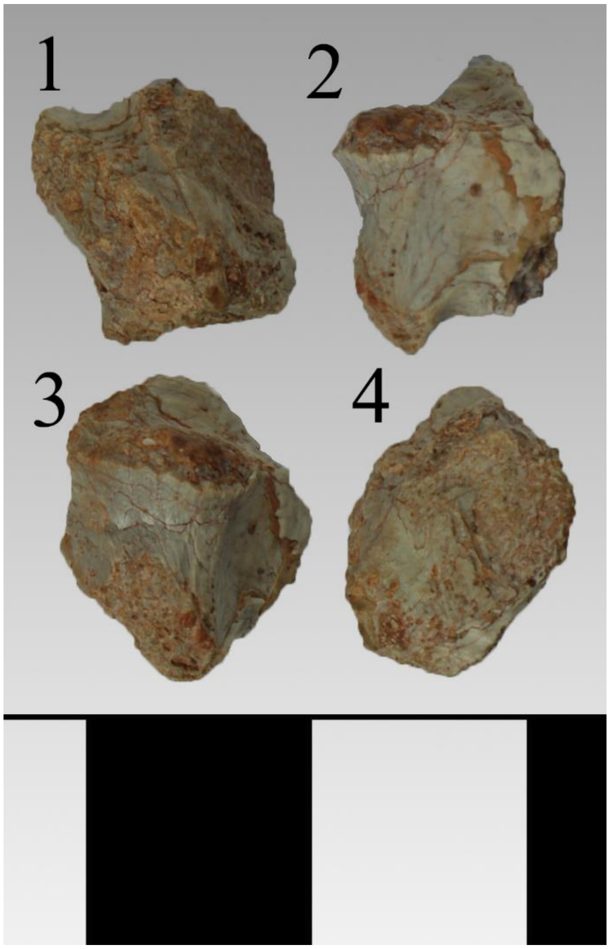

Figure 12: Possible neural arch fragment in four views. Scale: 1 box = 1 cm.

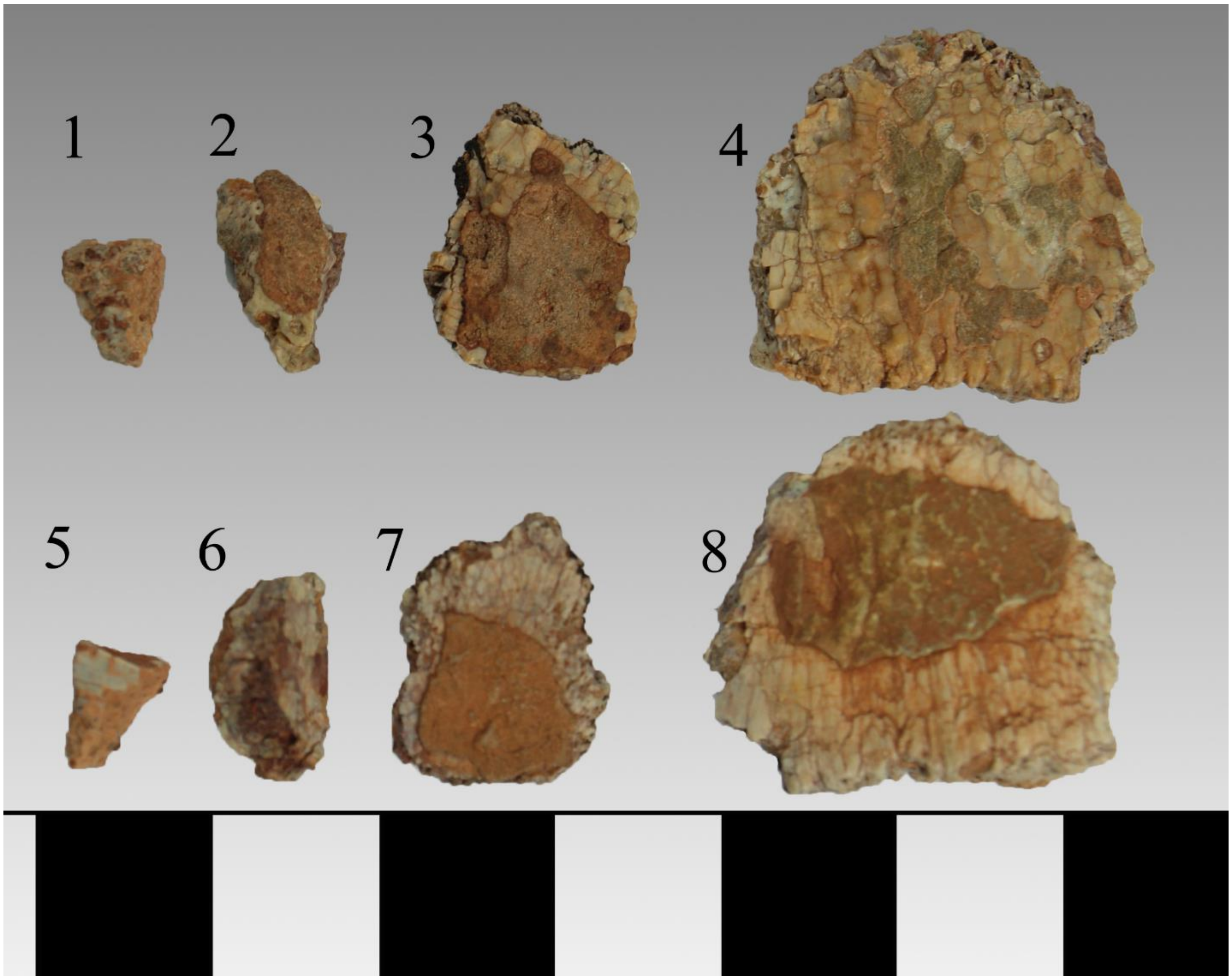

Figure 13: Four flat osteoderms in 1-4) lateral/dorsal, 5-8) medial/ventral views. Scale: 1 box = 1 cm.

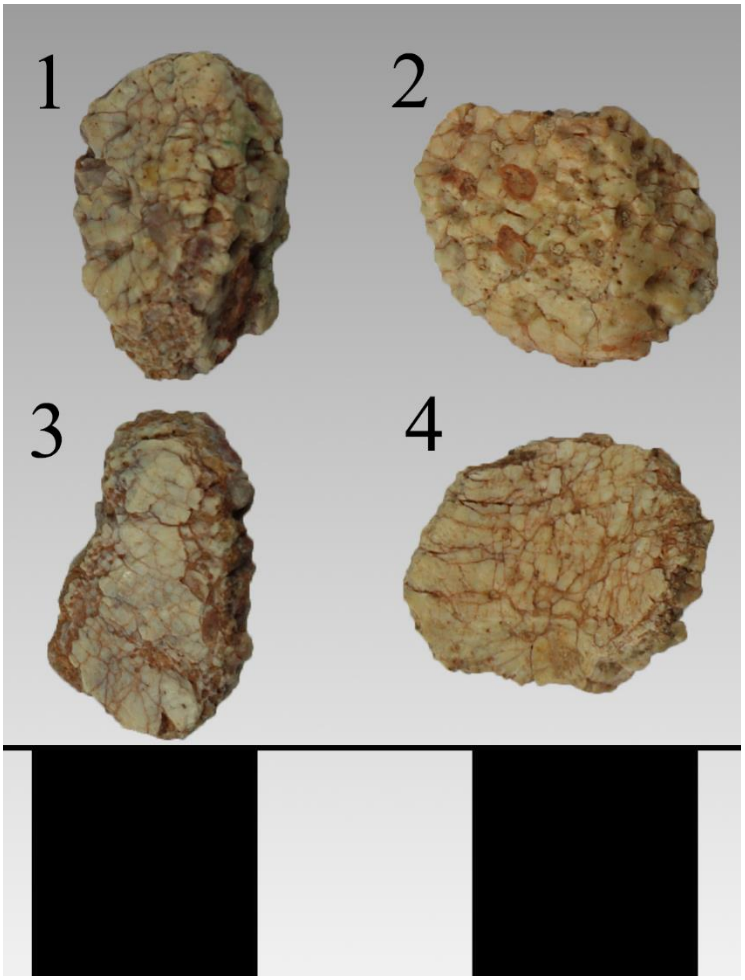

Figure 14: Two arched osteoderms in 1-2) lateral/dorsal, 3-4) medial/ventral views. Scale: 1 box = 1 cm.

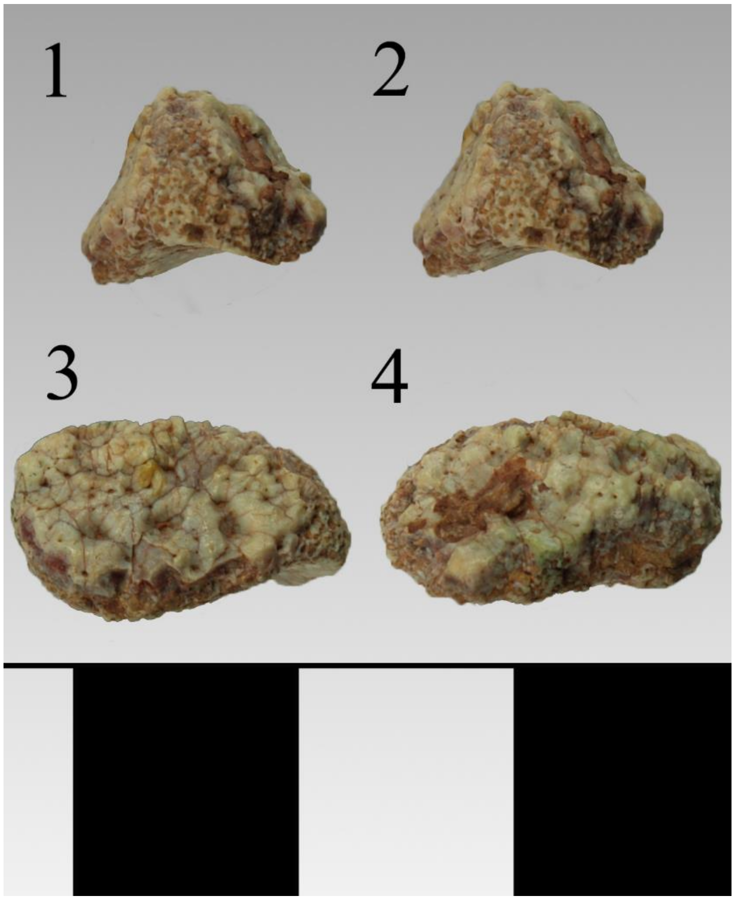

Figure 15: Osteoderm 1/3 from Figure 14 in 1-2) transverse, 3) dorsolateral, 4) ventrolateral views. Scale: 1 box = 1 cm.

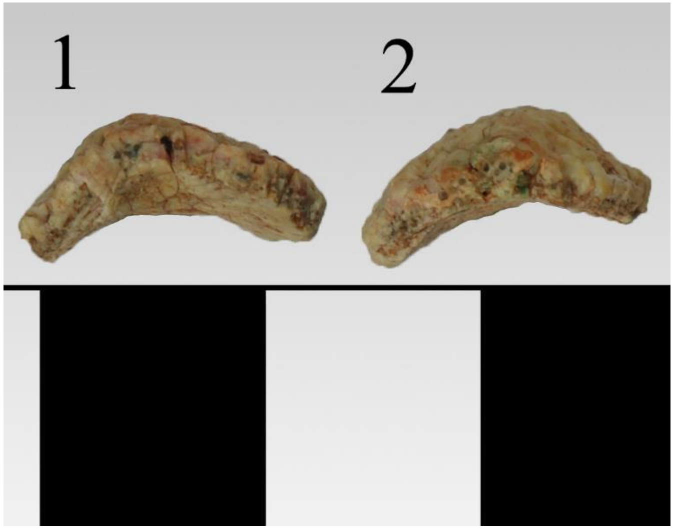

Figure 16: Osteoderm 2/4 from Figure 14 in transverse views. Scale: 1 box = 1 cm.