

A taphonomic assessment of the bovids from Malapa, South Africa and its implications for the accumulation of *Australopithecus sediba* fossils

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Introduction

Australopithecus sediba from Malapa, South Africa, holds important implications for understanding the origin of the genus *Homo* (Berger et al, 2010). This study addresses the faunal taphonomy at Malapa, the *Au. sediba* bearing vertical cave opening in South Africa (Figure 1). Specifically, these analyses assess the site's bovid assemblage and consider its implications for the associated *Au. sediba* material. This research determined that 21 identifiable bovid specimens were recovered from Malapa (Table 1). A minimum number of thirteen individuals were recovered from five different tribes. The assemblage is noteworthy in two important ways: 1) extraordinary preservation characterized by partially articulated skeletons; and 2) remarkable absence of accumulator tooth marks and/or hammerstone percussion breakage. The lack of taphonomically distinct marks suggests that there was no systematic collection of bones by a biotic, bone-accumulating agent.

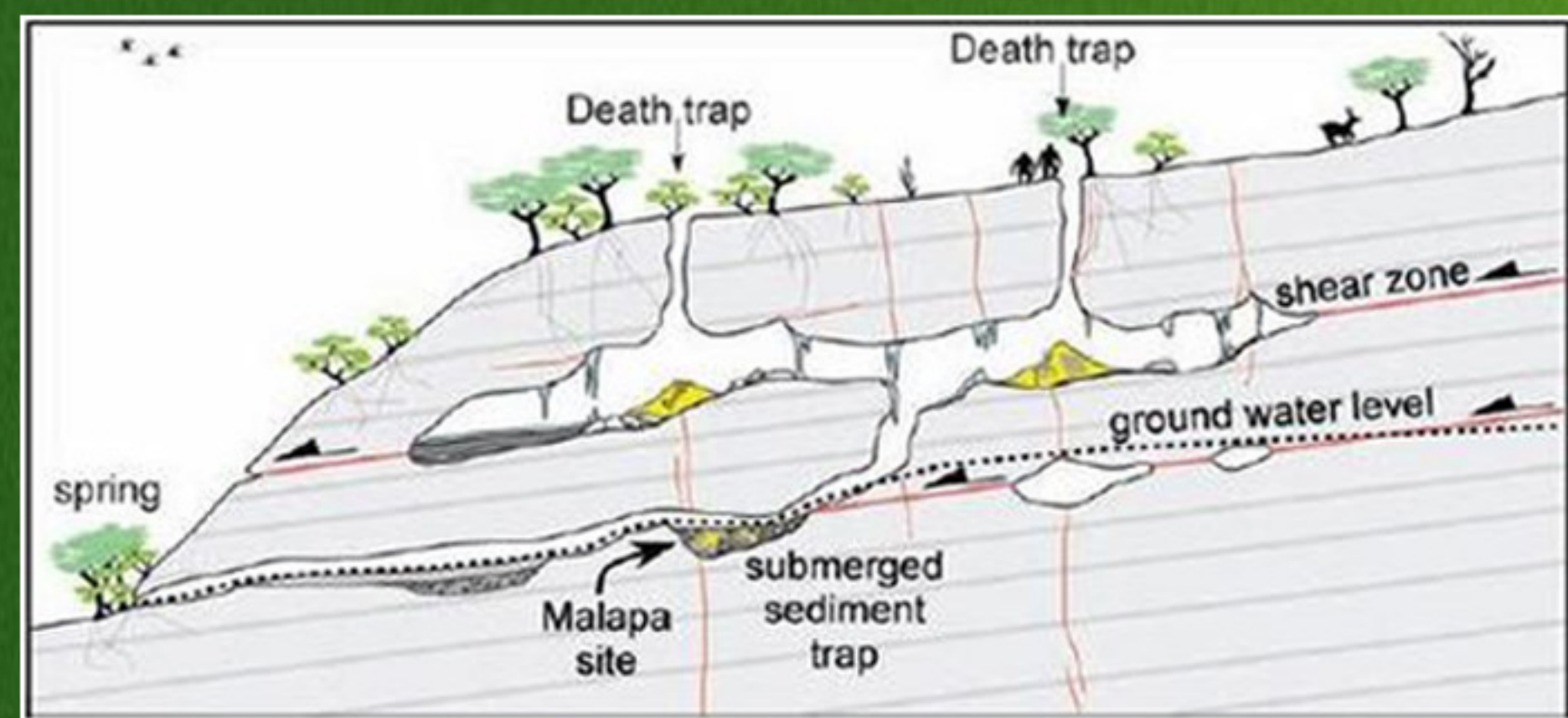


Figure 1. Illustration of vertical cave opening at Malapa from Dirks et al., 2010.

Table 1. Bovidae remains from Malapa, South Africa

Order Artiodactyla		NISP	MNI
Family Bovidae			
Tribe: Ovitovini	<i>Makapania broomi</i>	2	2
Tribe: Tragelaphini	<i>Tragelaphus scriptus</i>	4	1
Tribe: Alcelaphini	<i>Alcelaphini indeterminate</i>	2	2
	<i>Megalotragus sp.</i>	5	3
	<i>Connachaetes sp.</i>	3	2
Tribe: Antilopini	<i>Antidorcas australis/marsupialis</i>	2	2
Tribe: Neotragini	<i>Neotragini indeterminate</i>	3	1
Bovidae indeterminate		222	

Table 2. Bovidae postcranial skeletal part representation (NISP/MNE/MNI)

	BSI	BSII	BSIII
Humerus	3/2/1	5/2/1	
Femur	6/4/3	2/1/1	
Tibia	7/4/2	2/2/1	
Radius	3/3/2	2/2/1	
Ulna		5/4/2	
Metacarpal	5/4/3	7/3/2	
Metatarsal	2/2/2	6/2/1	
Metapodial	1/1/1	2/2/1	
Scapula	8/3/3	2/2/2	
Atlas	1/1/1		
Axis	1/1/1		
Cervical vertebra	7/7/2	1/1/1	
Thoracic vertebra	6/6/2	5/5/2	
Lumbar vertebra	8/5/2		
Caudal vertebra		1/1/1	
Stenebra	1/1/1		
Pelvis	1/1/1		
Ribs	32/5/1	10/4/1	
Sacrum	3/2/2		
Proximal phalanx	4/3/1	10/10/3	
Intermediate phalanx	1/1/1	4/4/2	7/7/2
Distal phalanx	2/2/1	2/2/1	
Accessory carpal	1/1/1		
Astragalus	3/3/2	1/1/1	
Calcaneus	4/3/3	2/2/2	
Internal cuneiform		1/1/1	
Cuneiform	1/1/1		
Lateral malleolus		1/1/1	
Magnum	2/2/1		
Naviculo-cuboid	2/2/1	1/1/1	
Scaphoid	1/1/1		
Unciform	1/1/1	1/1/1	
Sesamoid		7/7/2	

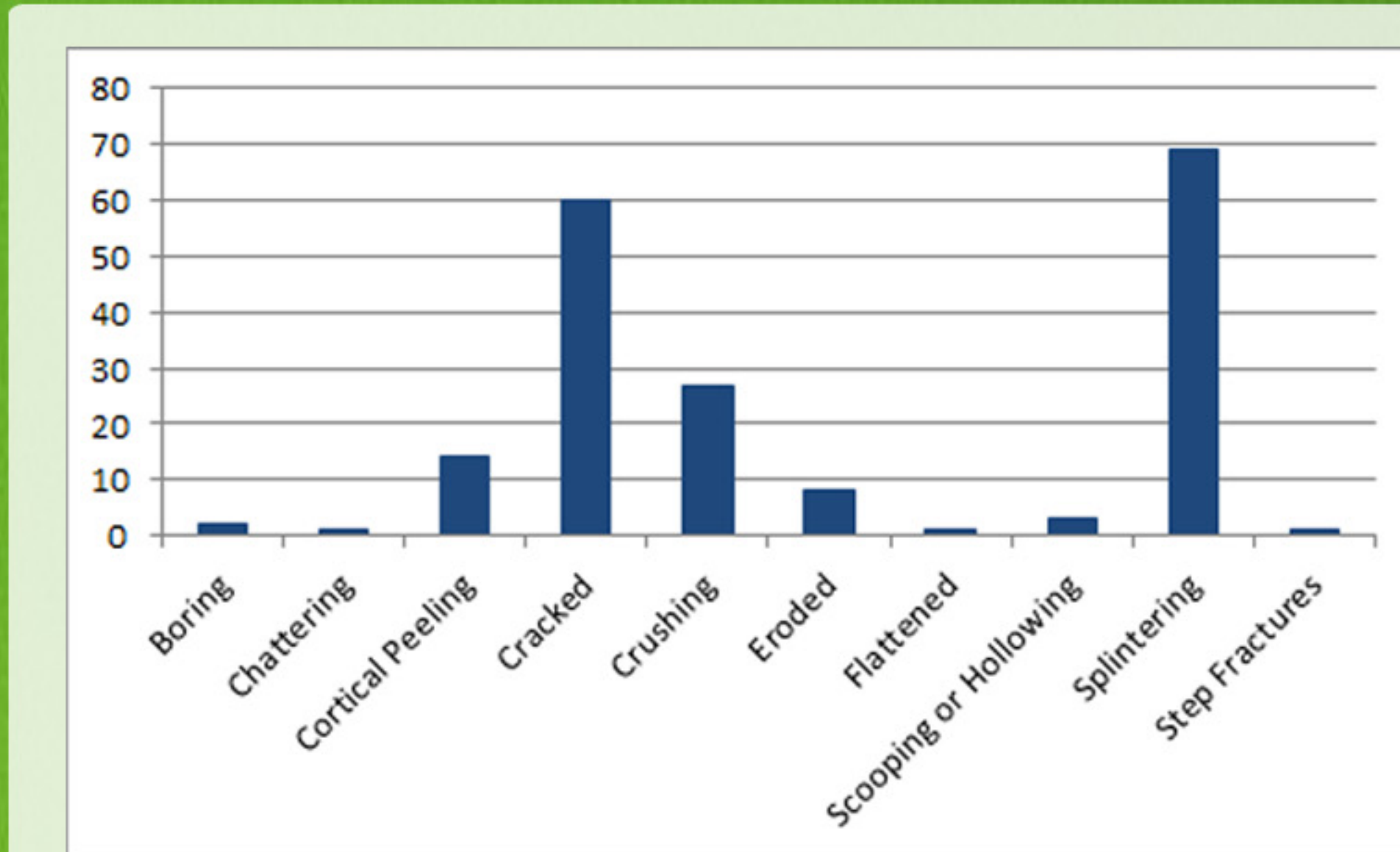


Figure 2. Surface damage found on Malapa bovid fossils

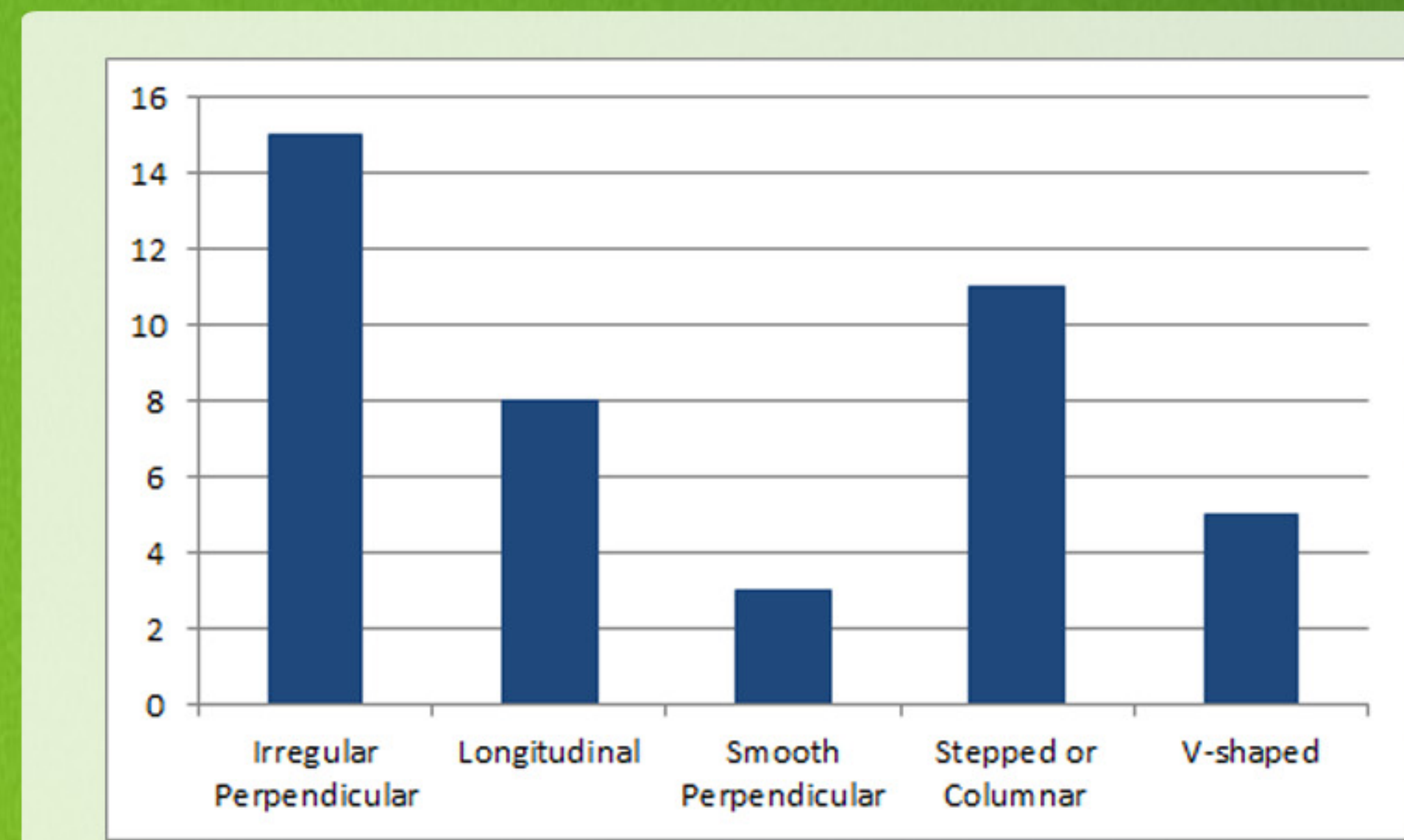


Figure 3. Fracture patterns evident on Malapa bovid fossils

Results

Thirteen individual bovids were identified from Malapa (Table 1). The skeletal part representation illustrates that the entire bovid skeleton is present at the site (Table 2). Most of the specimens are body size class II and III. Only approximately 10% of the assemblage exhibits trauma. These results may be consistent with a low energy fall or impact; none of the bovid remains have perimortem trauma consistent with a fall from significant height (See Figure 1). Moreover, a majority of the bovid long bone remains demonstrate surface damage consistent with dry, postdepositional fractures such as splintering, cracking, and crushing (Figure 2).

The fracture patterns (Figure 3) such as irregular perpendicular and breakage patterns (Figures 12-15) including transverse fracture outlines demonstrate how most of the bones exhibit postmortem and post fossilization fractures. These patterns suggest that there was sediment loading consistent with movement of the surrounding matrix (See Figures 4-11). These observations indicate that the bovids, and likely the hominins, entered the cave on their own, whether by accident or of their own volition, and were unable to escape.



Figure 4. Malapa specimen 88-1184 demonstrating cortical peeling



Figure 5. Malapa specimen 88-1247 demonstrating crushing and splintering surface damage



Figure 6. Malapa bovid specimens demonstrating splintering and cracking



Figure 7. Crushed and flattened bovid thoracic vertebra



Figure 8. Bovid fossils exhibiting transverse fracture outlines

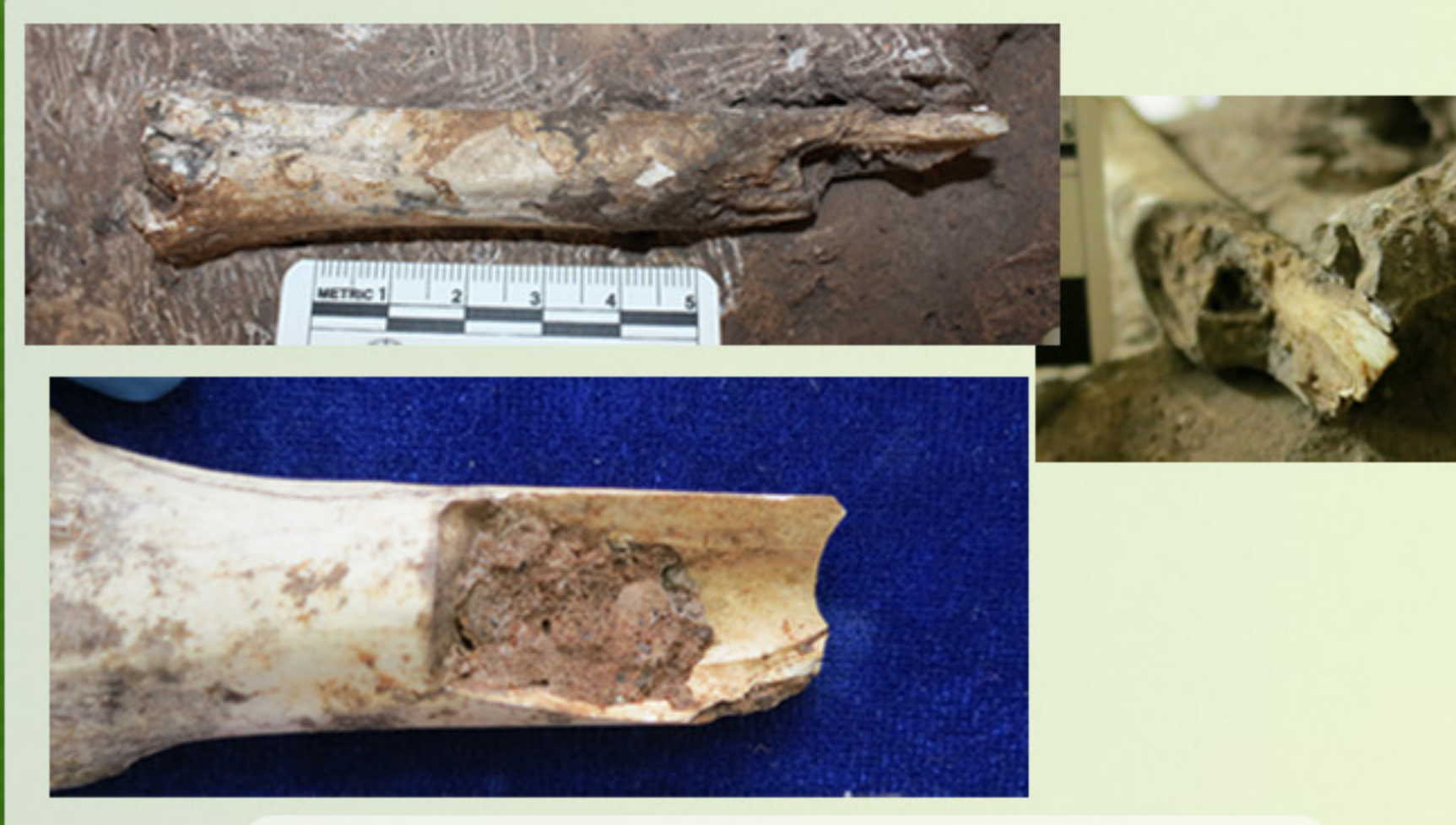


Figure 9. Bovid fossils with stepped and irregular surface modification



Figure 10. Bovid postcranial remains demonstrating sediment loading



Figure 11. Bovid vertebral column demonstrating sediment loading

Materials and Methods

The age, side, body weight class, and degree of completeness were documented for each bovid bone. The skeletal part representation was determined by analyzing the number of individual specimens (NISP) for each postcranial element, the minimum number of elements (MNE) those specimens comprise, and the comprehensive minimum number of individuals (cMNI) those elements encompass while considering factors such as age, side, size, and sex. All of the bovids were examined for taphonomic marks from bone accumulating agents. The surface modification and fracture pattern were documented for each bone. Finally, the breakage patterns of the postcranial bones as defined by Villa and Mahieu (1991) were recorded for each specimen.

References
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Dirks, P.H.D.M., Kibii, J.N., Kuhn, B.F., Steiner, C., Churchill, S.E., Kramers, J.D., Pickering, R., Farber, D.L., Mériaux, S.A., Herries, A.I.R., King, G.C.P., Berger, L.R., 2010. Geological setting and age of *Australopithecus sediba* from southern Africa. *Science* 328, 205–208.

Villa, P., Mahieu, E., 1991. Breakage patterns of human long bones. *J. Hum. Evol.* 21, 27–48.

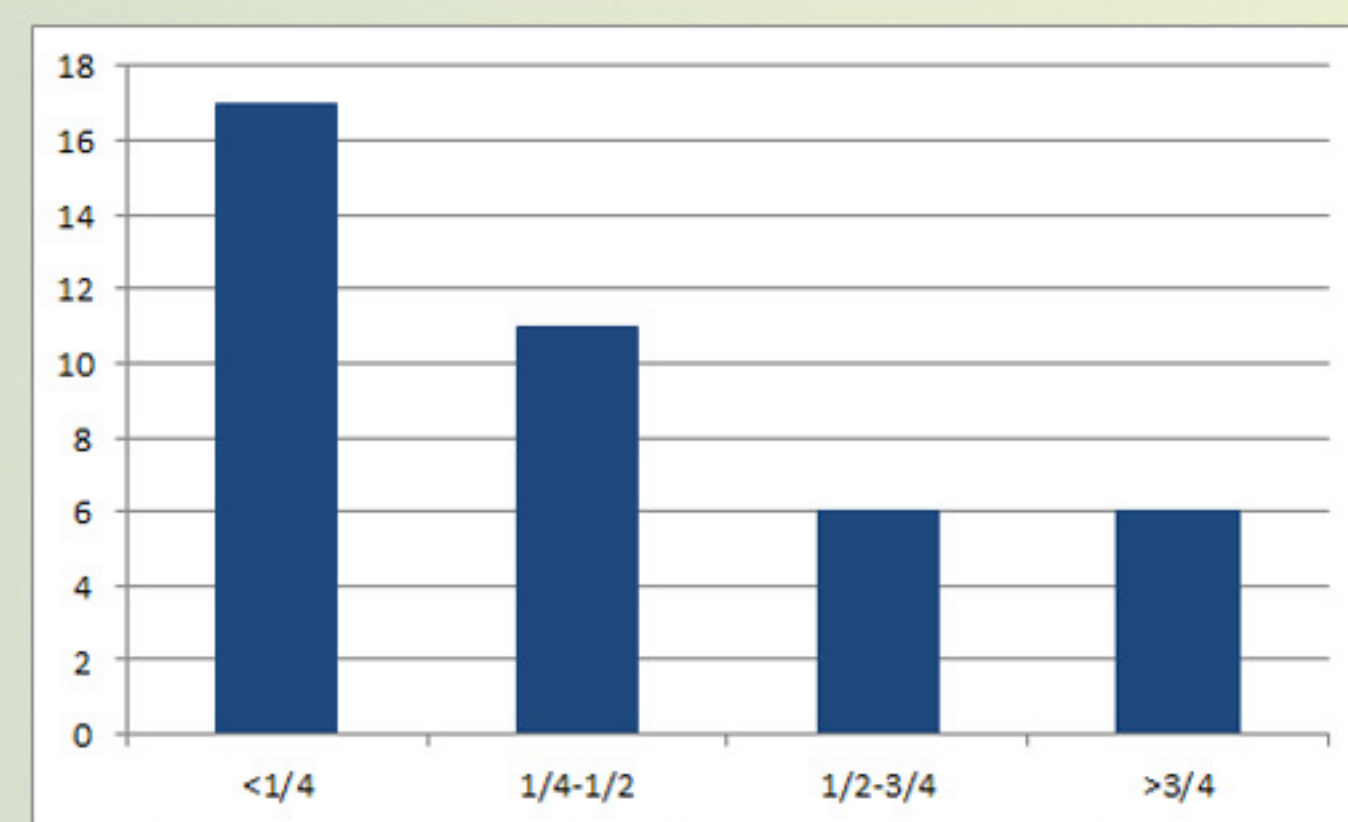


Figure 12. Shaft fragmentation of Malapa bovid postcranial fossils

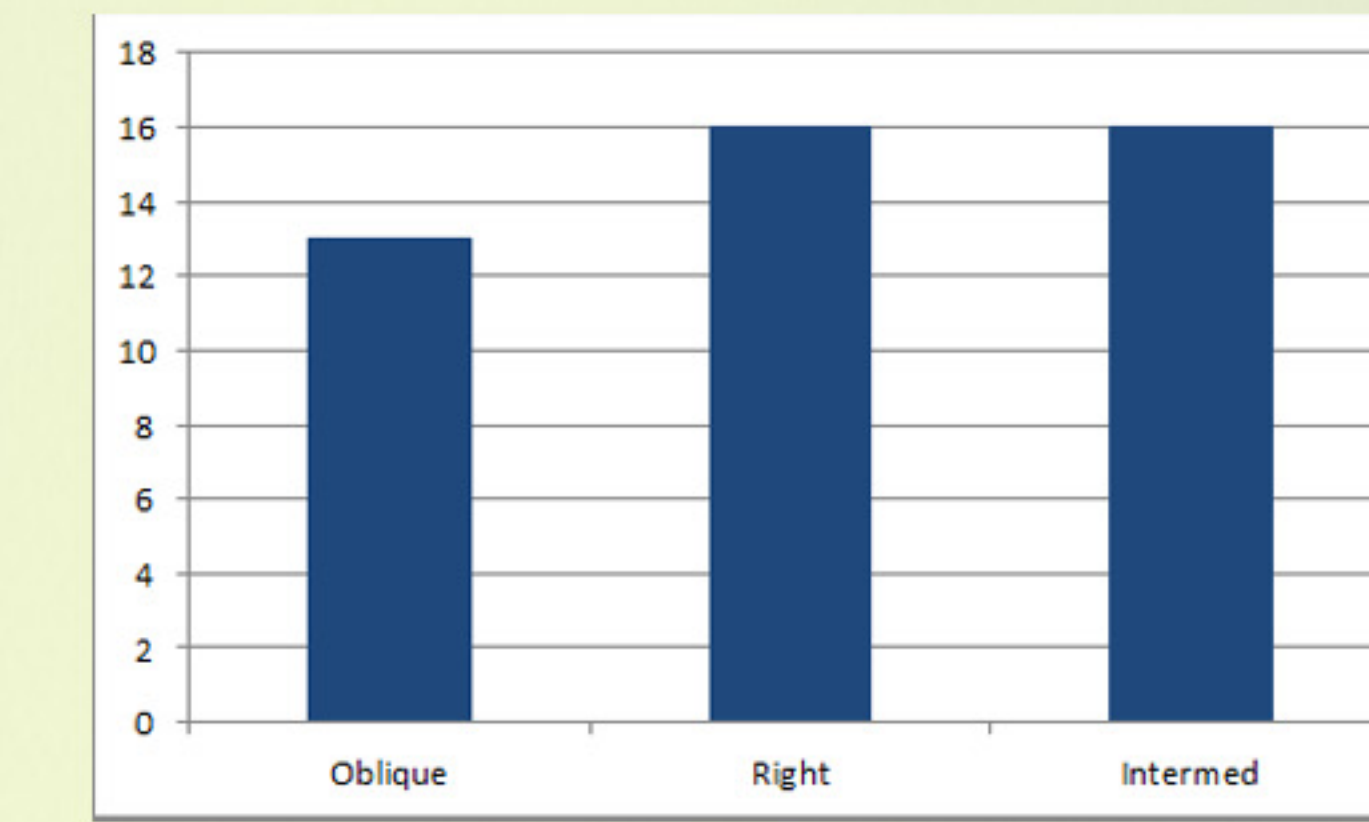


Figure 13. Fracture angle of Malapa bovid postcranial fossils

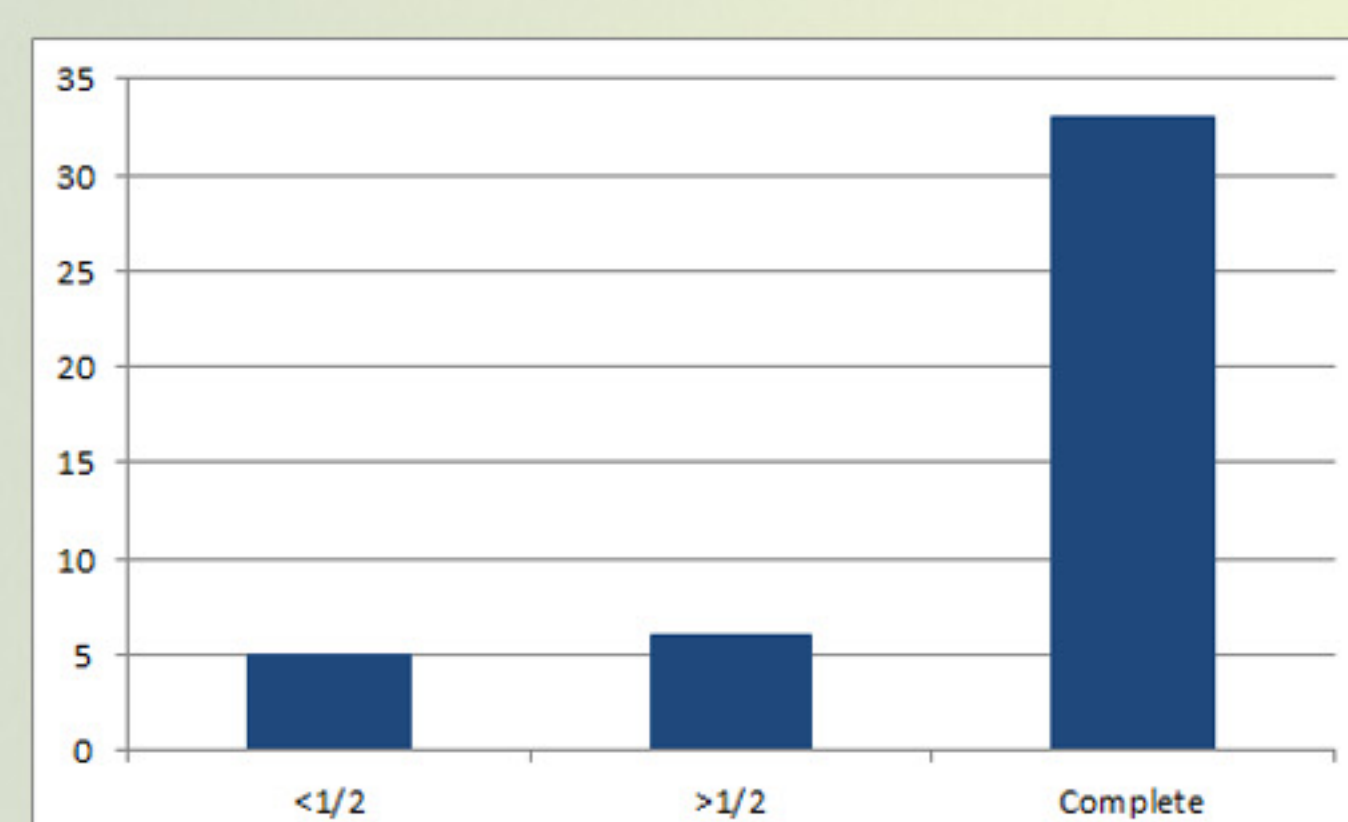


Figure 14. Shaft circumference of Malapa bovid postcranial fossils

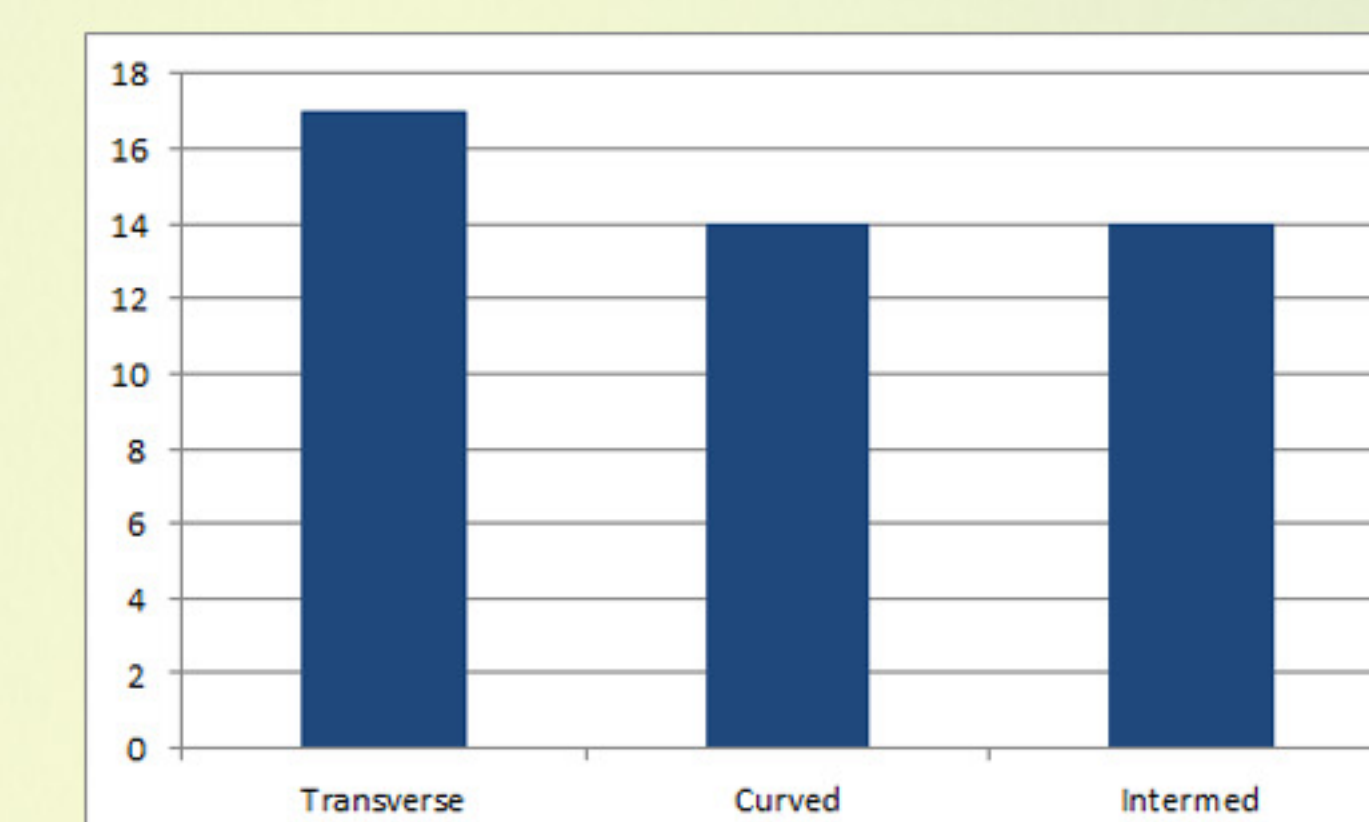


Figure 15. Fracture outline of Malapa bovid postcranial fossils

Summary and Conclusions

- No skeletal element bias at Malapa
- Bovid remains do not exhibit perimortem trauma consistent with a significant fall
- Surface damage and fracture patterns consistent with postdepositional fractures
- Breakage patterns indicate abiotic, sediment loading likely affected the bones
- Lack of taphonomically distinct marks suggests that there was no systematic collection of bones
- Results of the taphonomic analyses suggest the bovids, and likely *Au. sediba*, entered the cave opening by accident or of their own volition