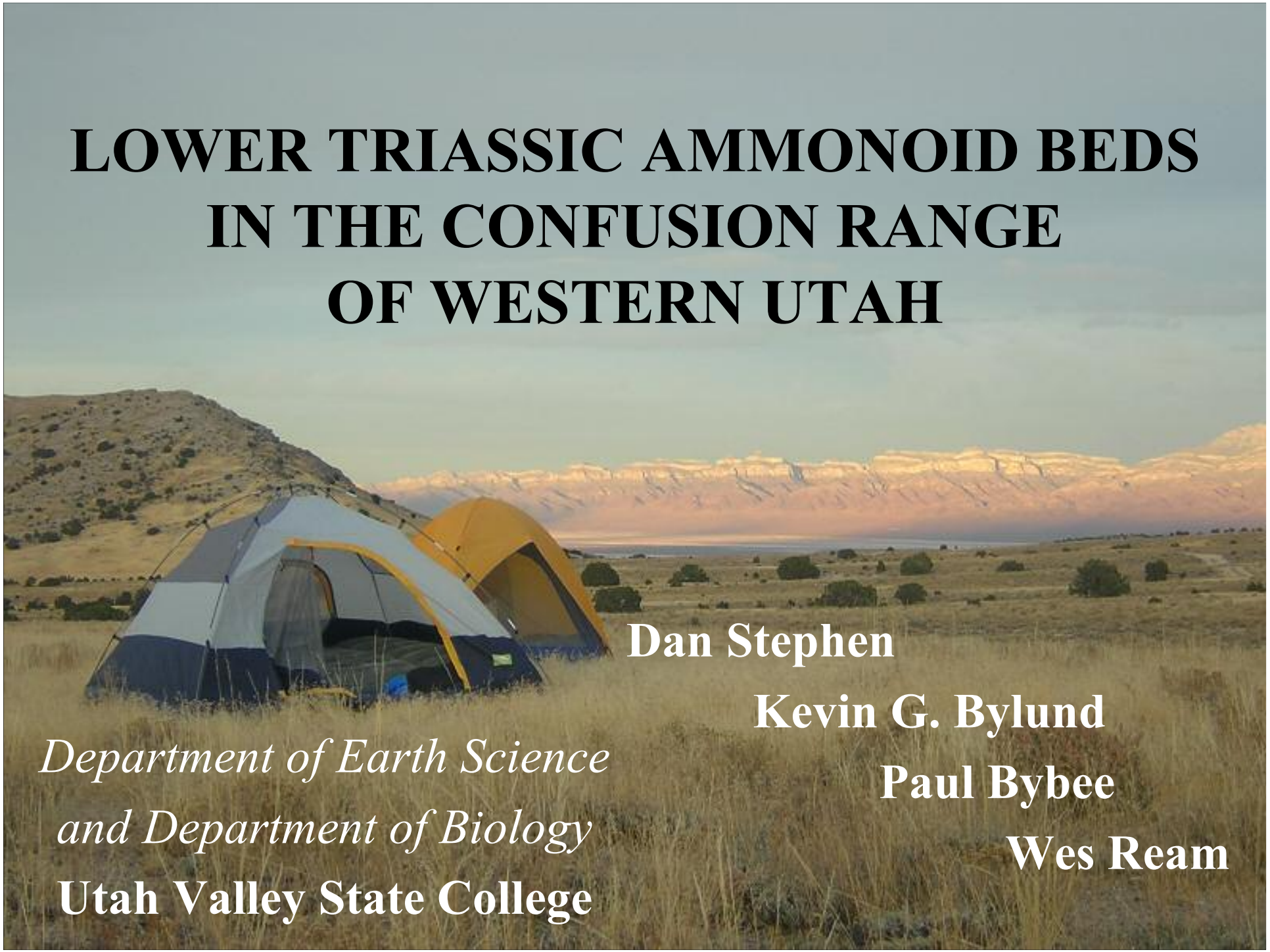
LOWER TRIASSIC AMMONOID BEDS IN THE CONFUSION RANGE OF WESTERN UTAH



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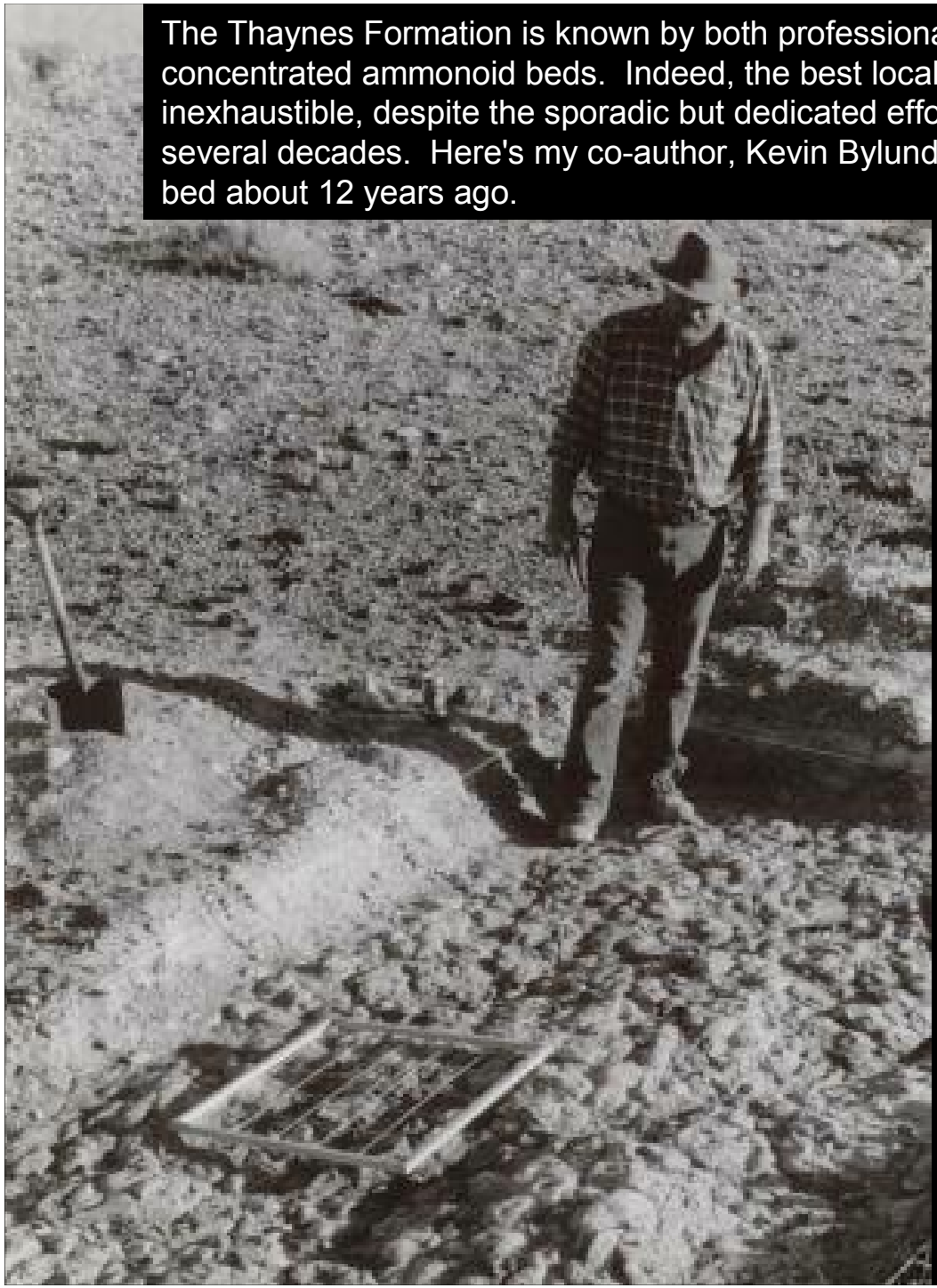
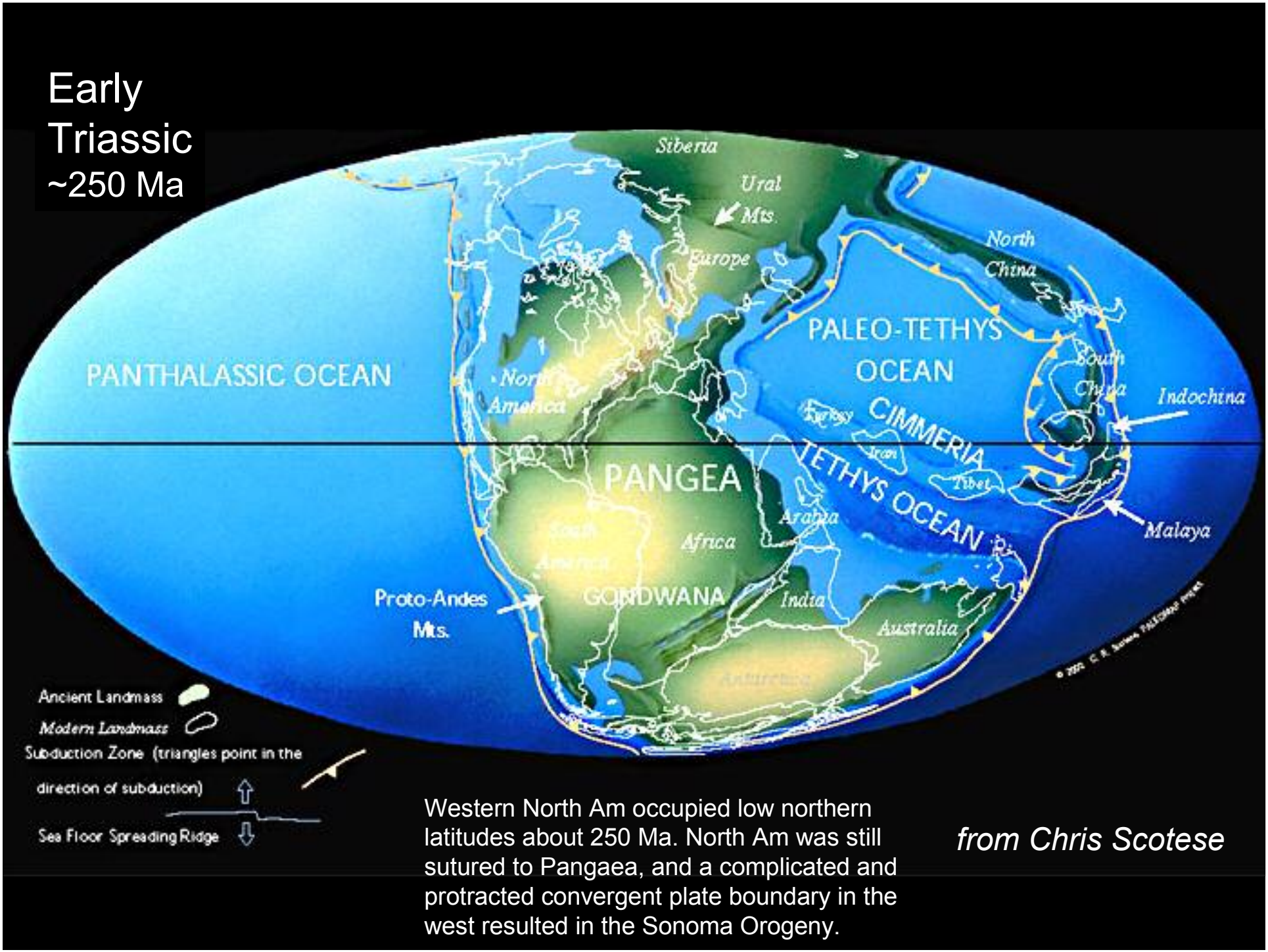
The Thaynes Formation is known by both professionals and amateurs for its densely concentrated ammonoid beds. Indeed, the best locality in the Confusion Range seems to be inexhaustible, despite the sporadic but dedicated efforts of collectors over at least the past several decades. Here's my co-author, Kevin Bylund, doing a grid study of a Thaynes ammonoid bed about 12 years ago.

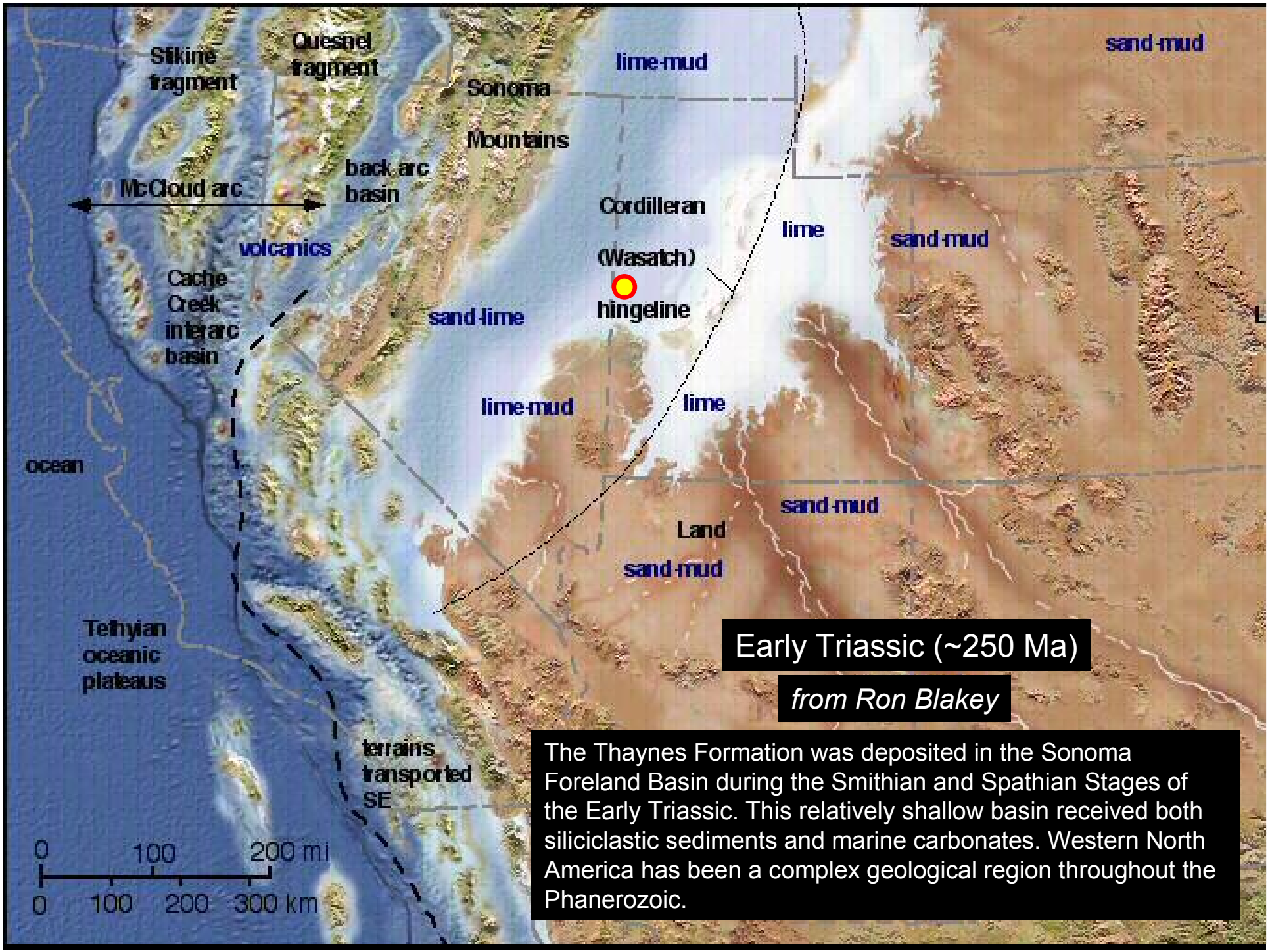


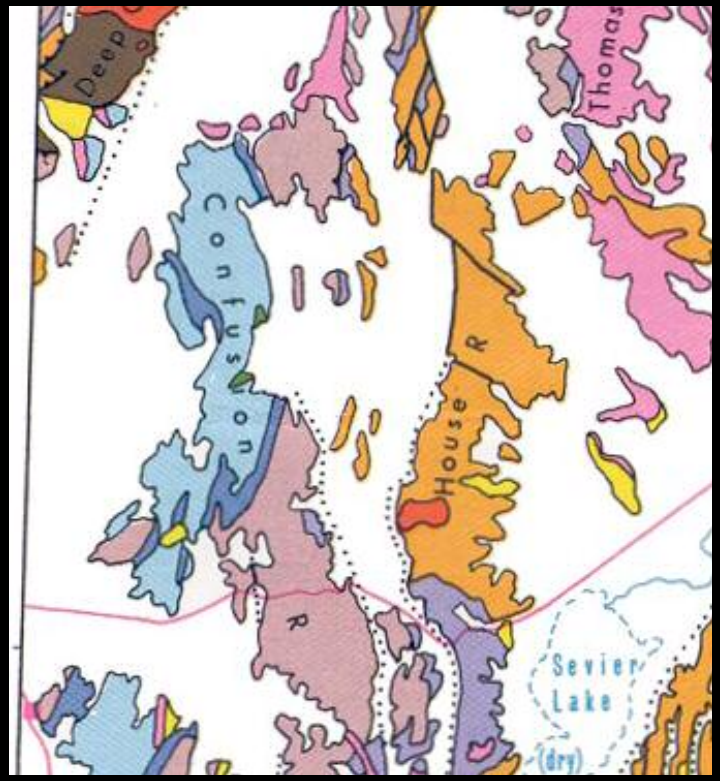
Early Triassic ~250 Ma



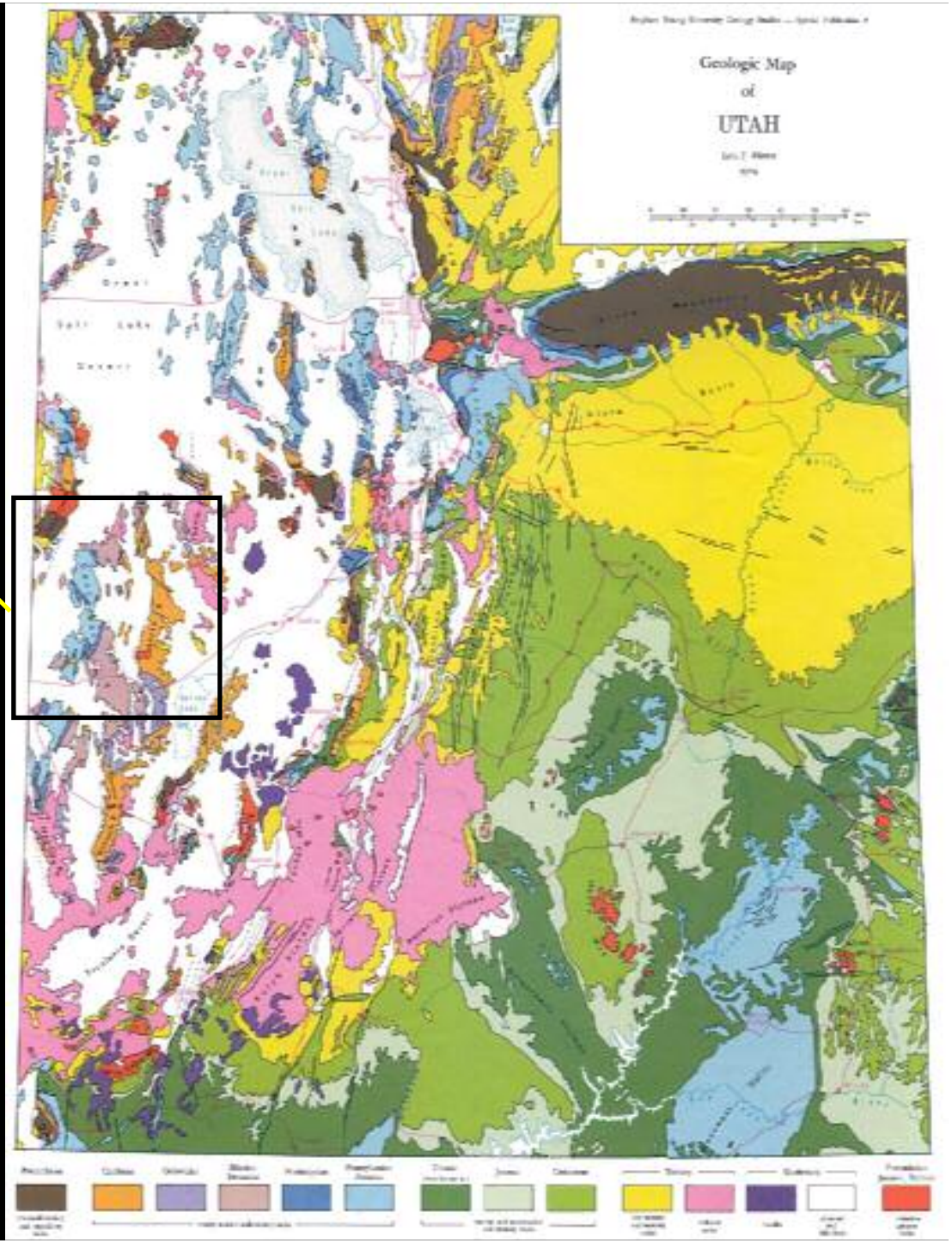
Western North Am occupied low northern latitudes about 250 Ma. North Am was still sutured to Pangaea, and a complicated and protracted convergent plate boundary in the west resulted in the Sonoma Orogeny.

from Chris Scotese

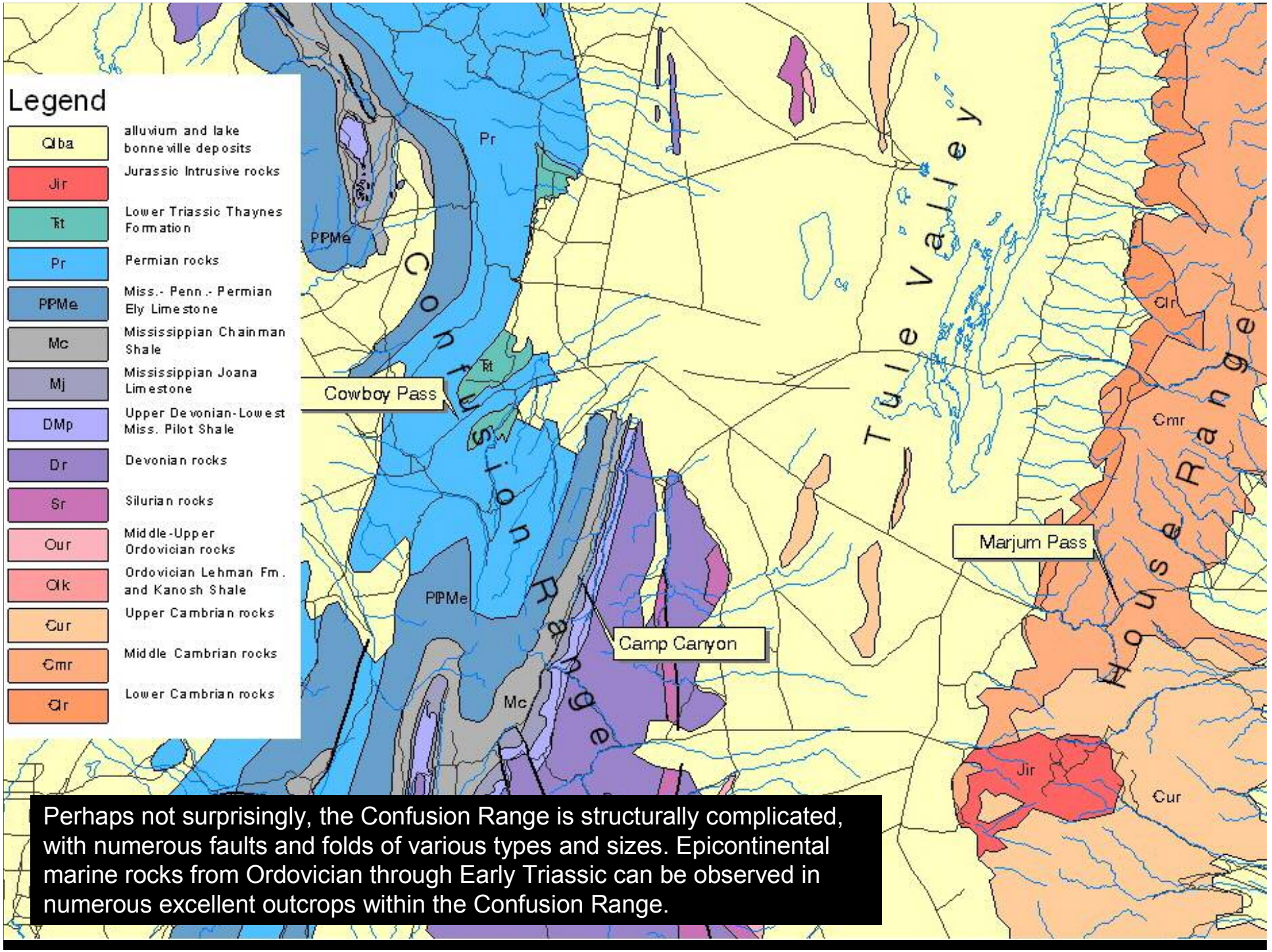

Stikine fragment
Quesnel fragment
Sonoma Mountains
lime-mud
sand-mud
back arc basin
McCloud arc
Cordilleran (Wasatch) hingeline
lime
sand-mud
volcanics
Cache Creek interarc basin
sand-lime
lime-mud
lime
ocean
sand-mud
Land
sand-mud
Tethyian oceanic plateaus
terrains transported SE
0 100 200 mi
0 100 200 300 km
Early Triassic (~250 Ma)
from Ron Blakey
The Thaynes Formation was deposited in the Sonoma Foreland Basin during the Smithian and Spathian Stages of the Early Triassic. This relatively shallow basin received both siliciclastic sediments and marine carbonates. Western North America has been a complex geological region throughout the Phanerozoic.



The current geological context of the Basin and Range Province, including western Utah, consists mostly of large-scale normal faults resulting in linear north-south mountain ranges separated by long narrow flat desert basins. Geological structures of this area are the consequence of Mesozoic compressional tectonics (mainly associated with the Sevier Orogeny) as well as later Cenozoic extensional tectonics.

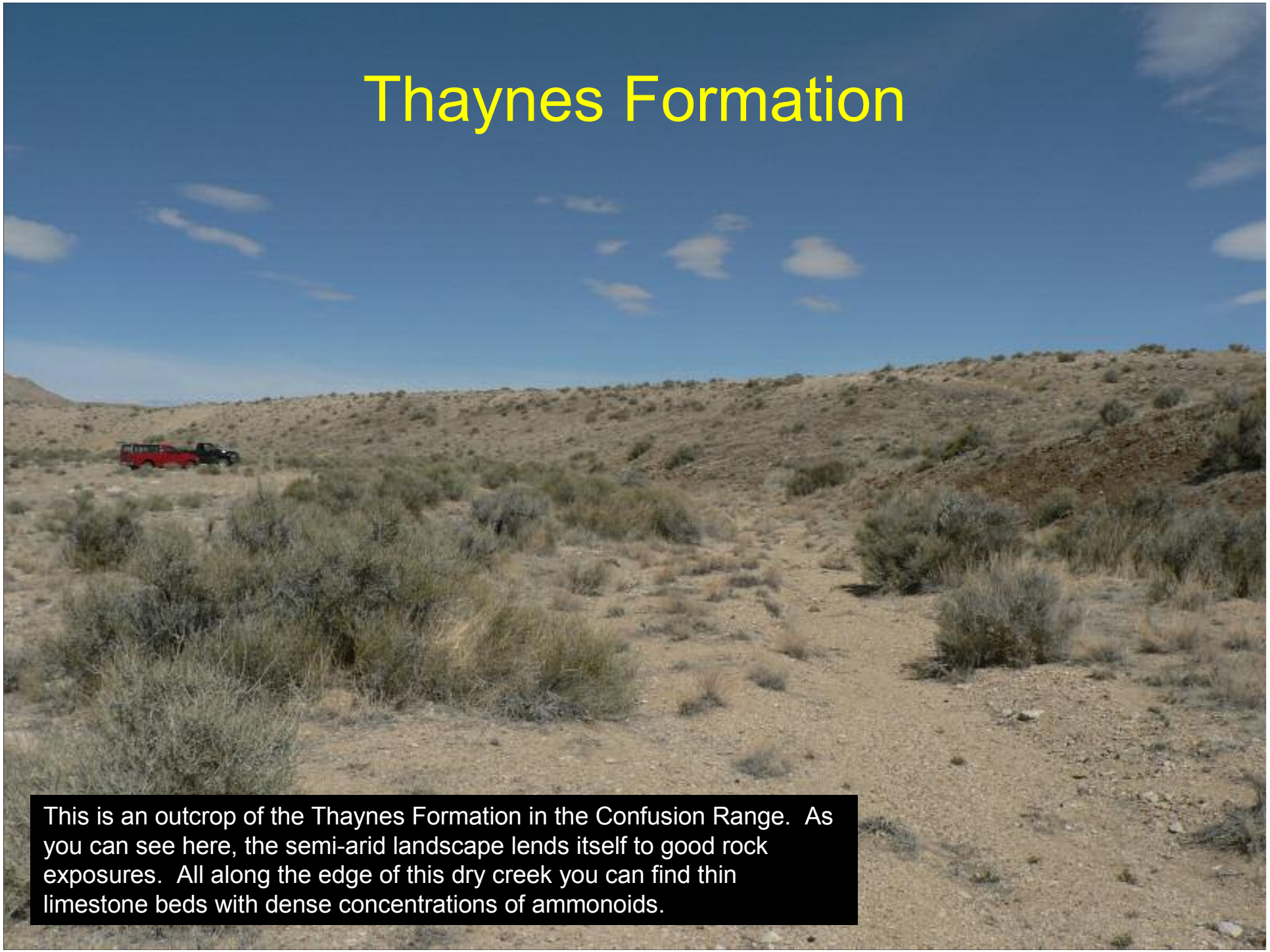


Here's a photo of one of our study sites. You can see part of the House Range in the background, and then the foothills of the Confusion Range, with the playas of the Tule Valley intervening



Perhaps not surprisingly, the Confusion Range is structurally complicated, with numerous faults and folds of various types and sizes. Epicontinental marine rocks from Ordovician through Early Triassic can be observed in numerous excellent outcrops within the Confusion Range.

Thaynes Formation



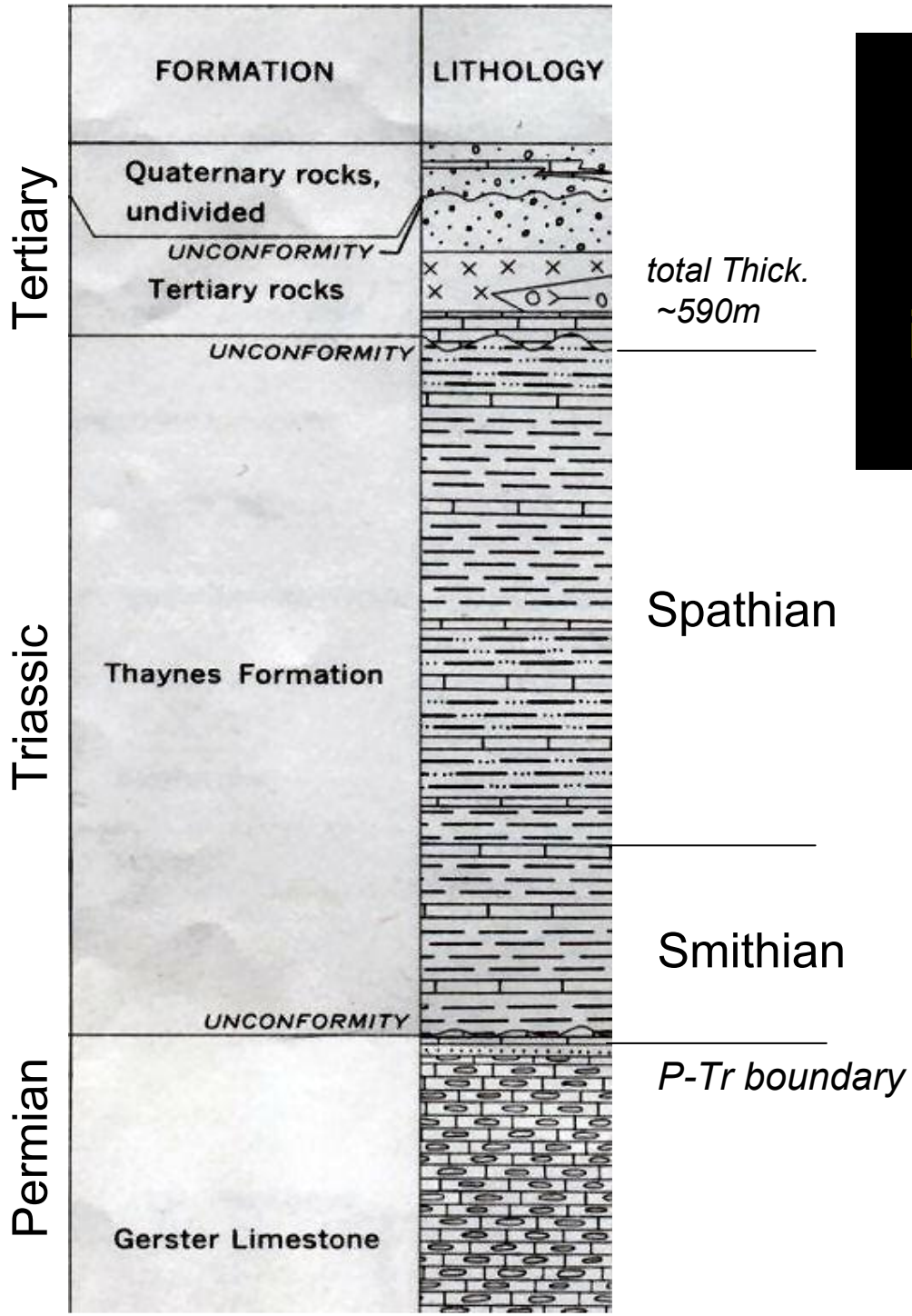
This is an outcrop of the Thaynes Formation in the Confusion Range. As you can see here, the semi-arid landscape lends itself to good rock exposures. All along the edge of this dry creek you can find thin limestone beds with dense concentrations of ammonoids.

an outcrop of the Anasibirites Beds

This is one of those ammonoid beds. Notice the rubble on the right-- that's where some collectors have been active recently.

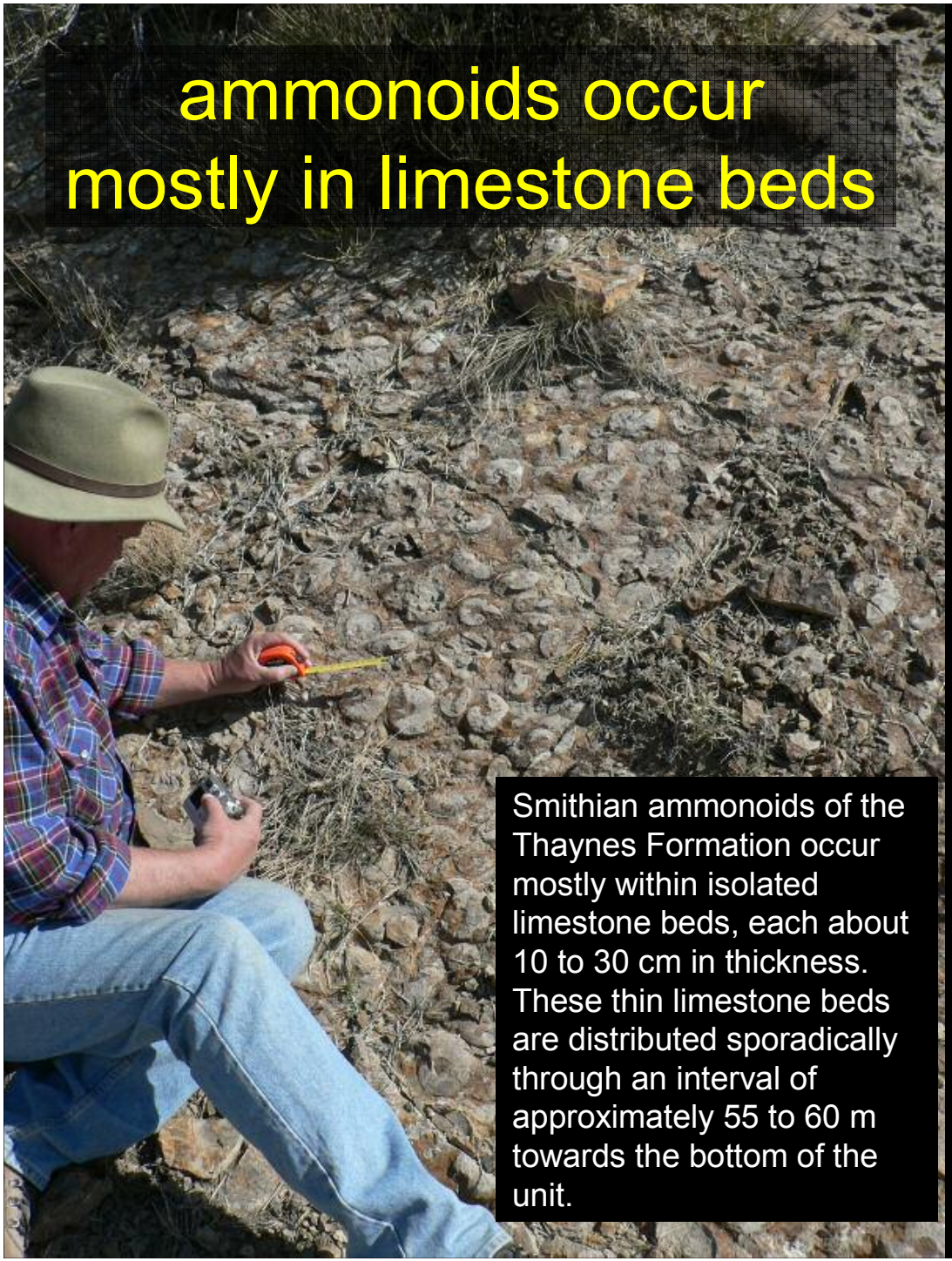
This is a closer look at the surface of the outcrop: well exposed, but quite a bit of fracturing and dissolution, despite the current dry climate.

composite measured stratigraphic section of the Thaynes Fm. in the Confusion Range of western Utah

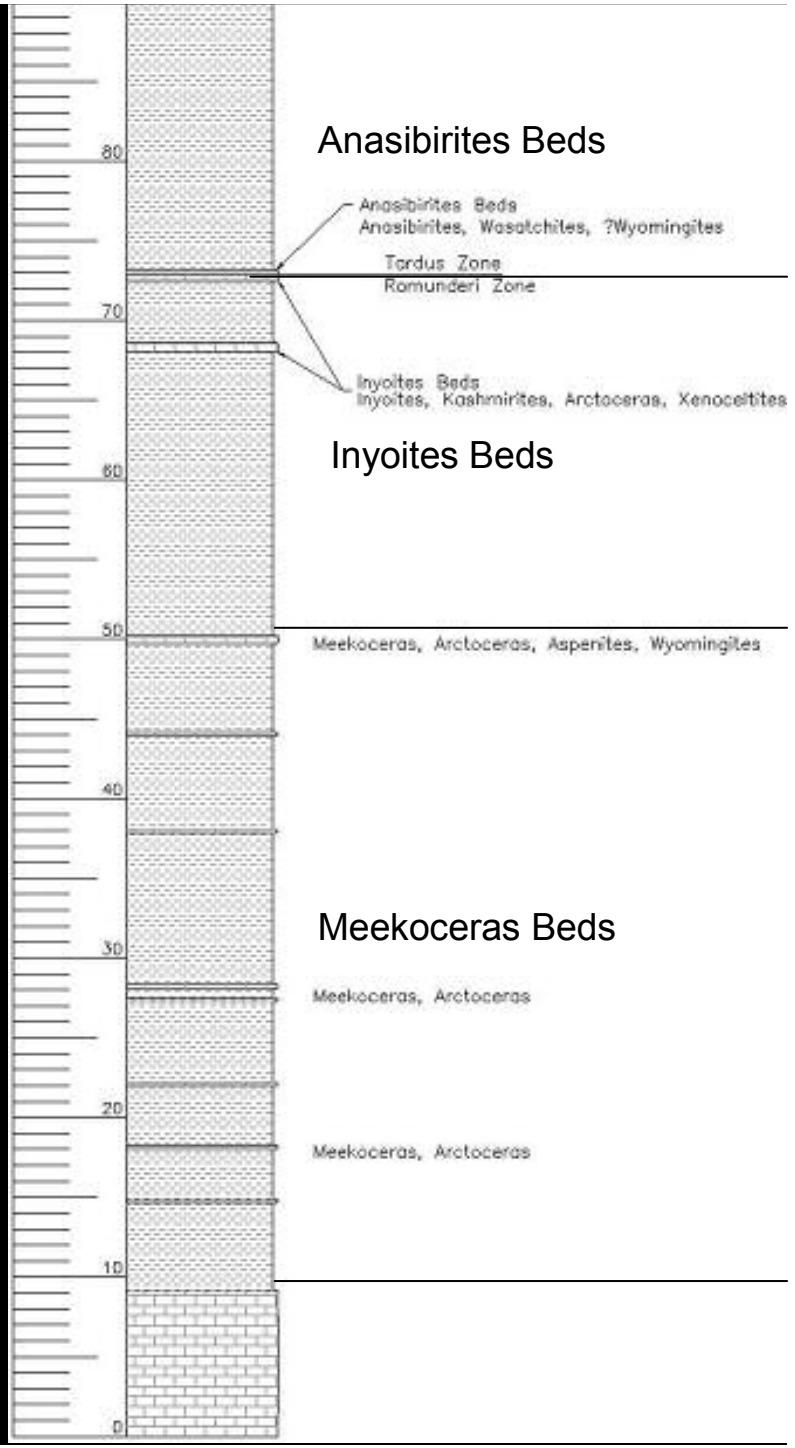


In the Confusion Range, the Lower Triassic Thaynes Formation lies unconformably above the Permian Gerster Formation and below Cenozoic volcanic and alluvial deposits. Most of the Thaynes Formation in western Utah consists of yellow-gray fissile shale and gray-brown limestone that reflect deposition in relatively calm water conditions equivalent to basin and outer shelf facies. Occasional, short-term regressions produced a few thin layers of inner shelf limestone, siltstone, sandstone, and some red beds. Total unit thickness is approximately 590 m. The formation includes both Smithian and Spathian rocks, though our present study focuses on ammonoid occurrences in the Smithian stage.

ammonoids occur mostly in limestone beds

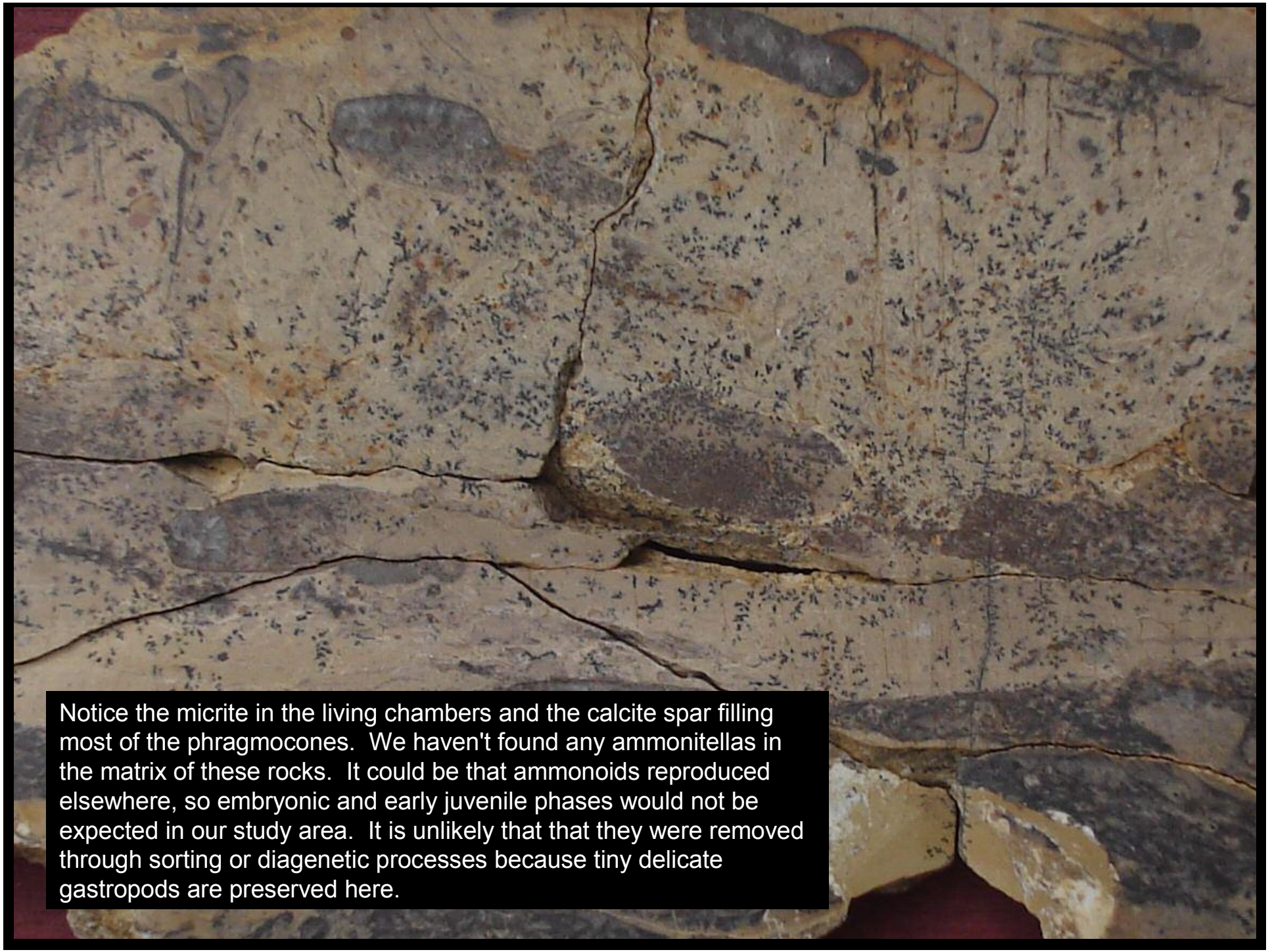


Smithian ammonoids of the Thaynes Formation occur mostly within isolated limestone beds, each about 10 to 30 cm in thickness. These thin limestone beds are distributed sporadically through an interval of approximately 55 to 60 m towards the bottom of the unit.



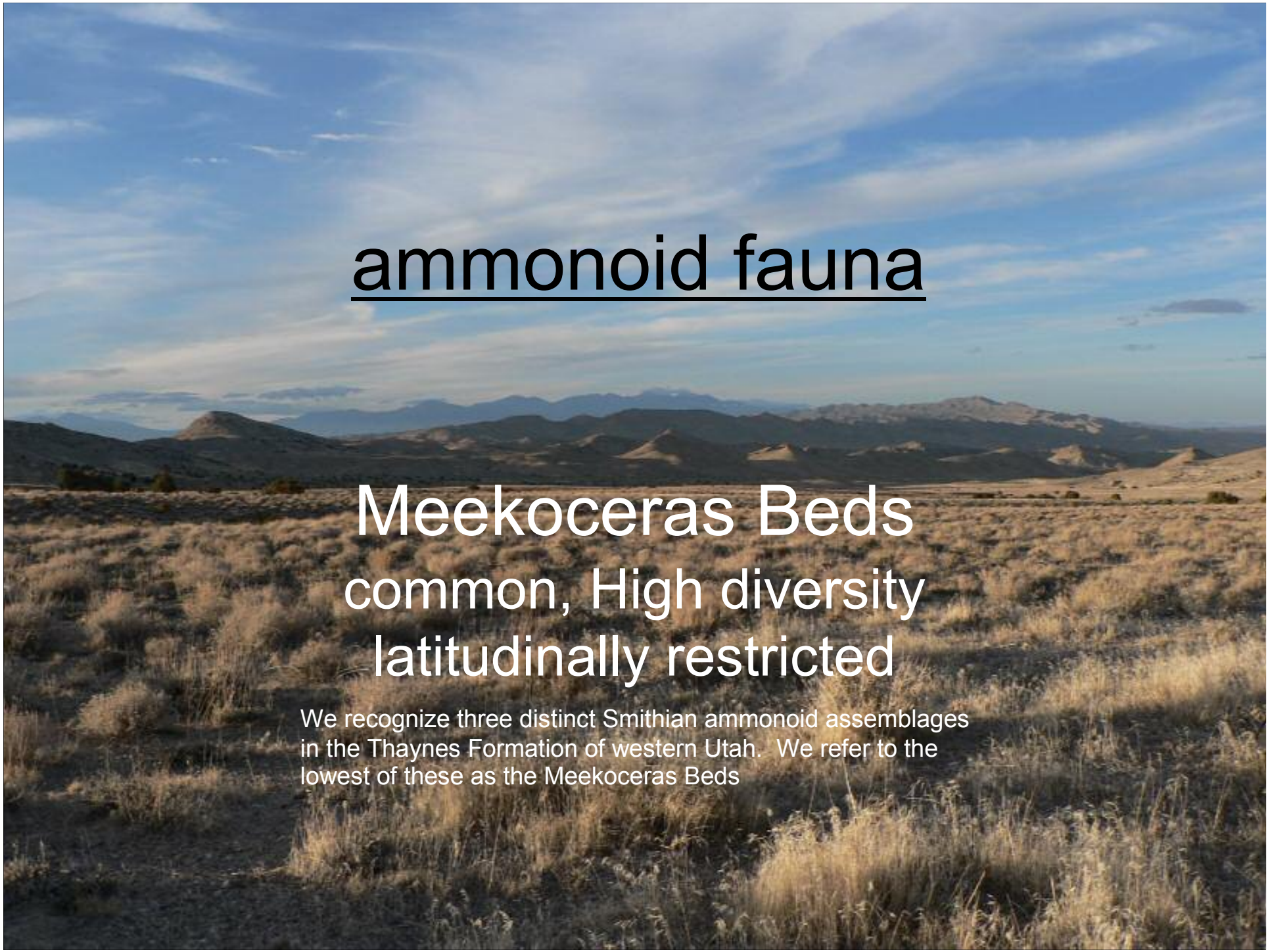
These limestone beds are mostly composed of micrite and bioclasts, with varying amounts of siliciclastic material. This is a photo of the top of the upper Anasibirites Bed. All of the cephalopods in this photo are Anasibirites, except for that little nautiloid in the center. Note the wide range in shell size.


scale is
in inches
Here's a slab section we made. This is a typical sample of the well-indurated but fairly brittle wackestones and packstones from the Anasibirites Beds.



Notice the micrite in the living chambers and the calcite spar filling most of the phragmocones. We haven't found any ammonitellas in the matrix of these rocks. It could be that ammonoids reproduced elsewhere, so embryonic and early juvenile phases would not be expected in our study area. It is unlikely that that they were removed through sorting or diagenetic processes because tiny delicate gastropods are preserved here.

typical surface collection



ammonoid fauna

Meekoceras Beds

common, High diversity

latitudinally restricted

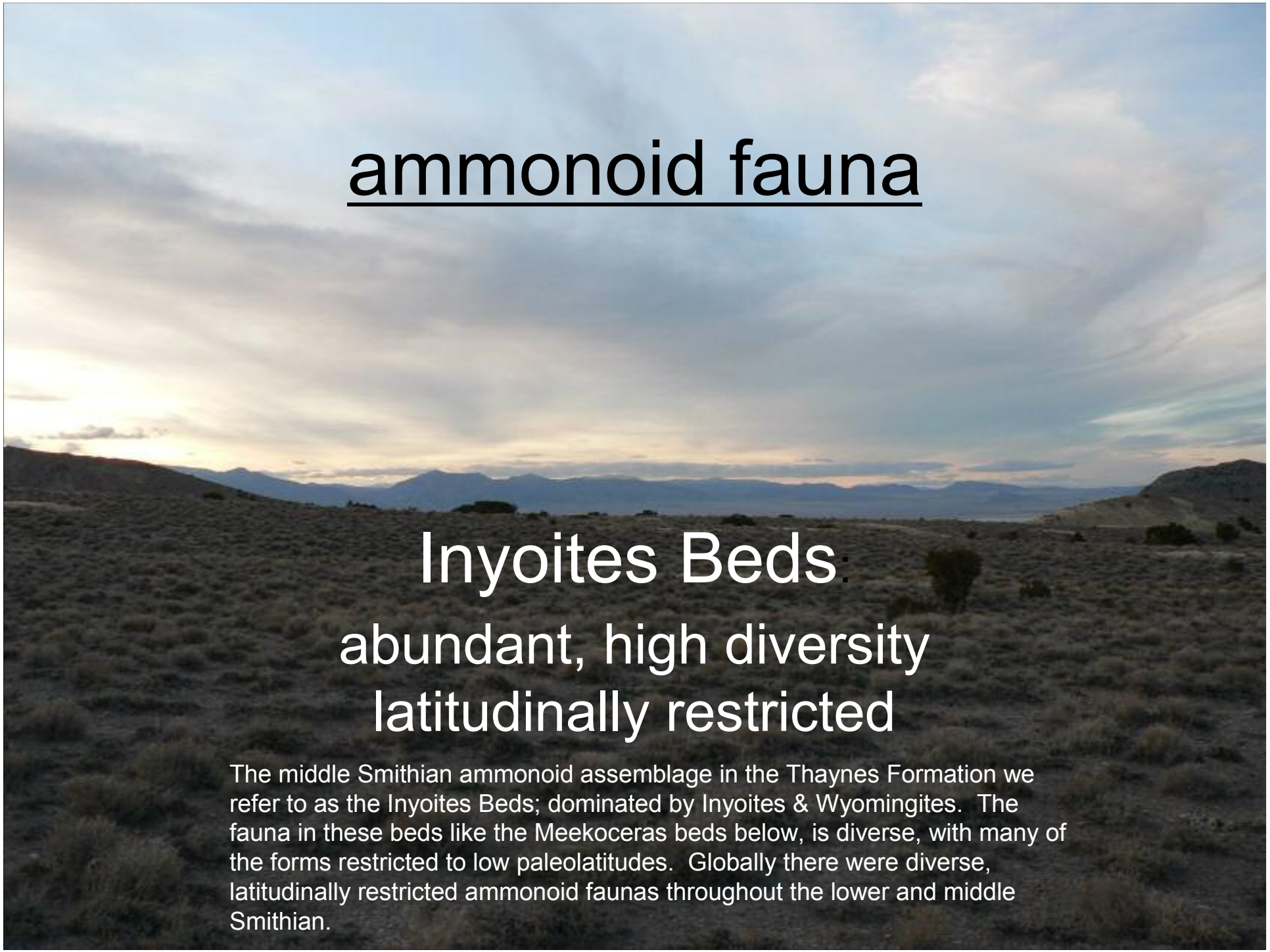
We recognize three distinct Smithian ammonoid assemblages in the Thaynes Formation of western Utah. We refer to the lowest of these as the Meekoceras Beds


Meekoceras gracilitatis

Submeekoceras mushbachanum


Aspenites acutus
4
5
6
7
8
9


Wyomingites aplanatus



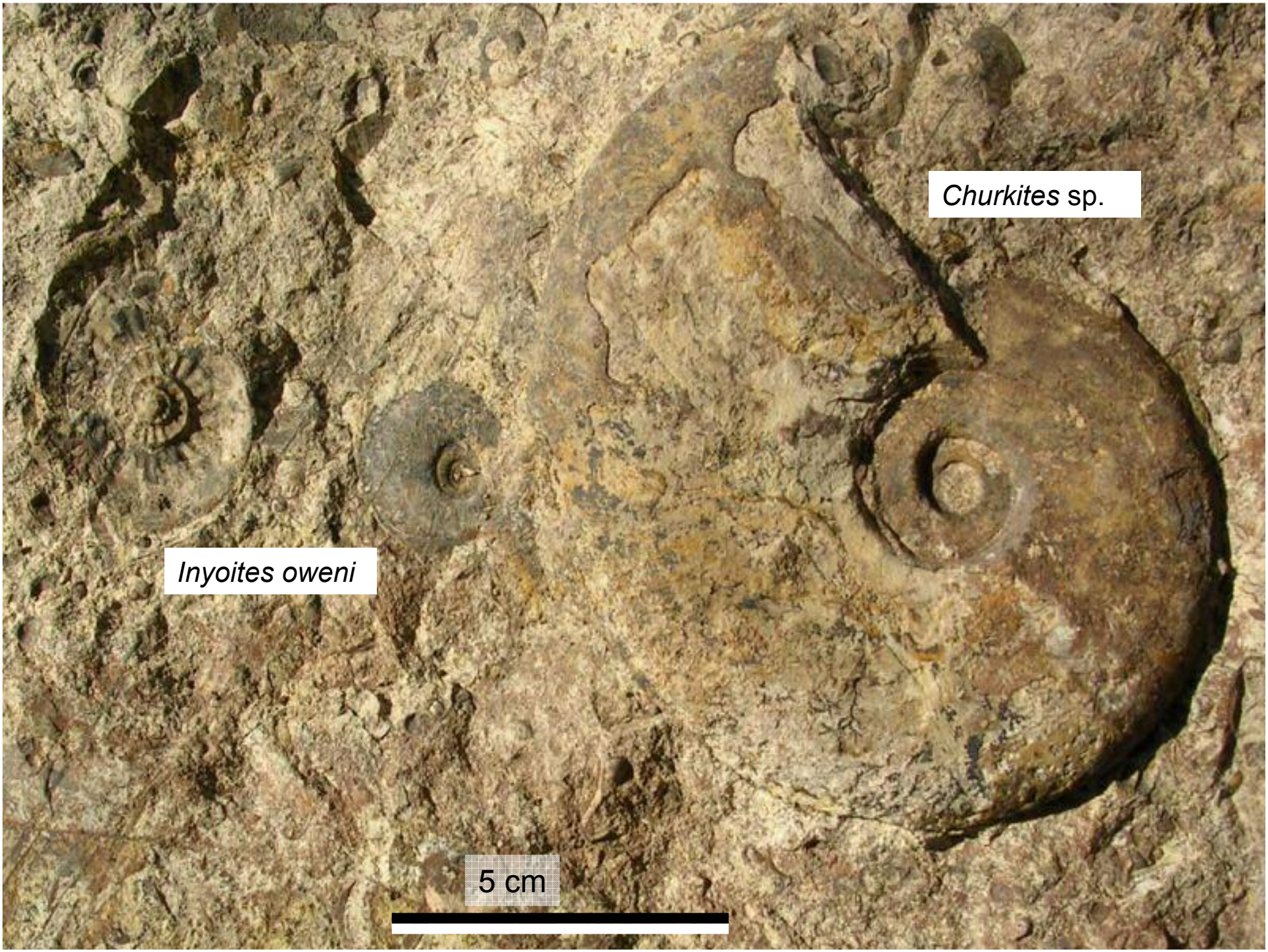
ammonoid fauna

Inyoites Beds:

abundant, high diversity
latitudinally restricted

The middle Smithian ammonoid assemblage in the Thaynes Formation we refer to as the Inyoites Beds; dominated by Inyoites & Wyomingites. The fauna in these beds like the Meekoceras beds below, is diverse, with many of the forms restricted to low paleolatitudes. Globally there were diverse, latitudinally restricted ammonoid faunas throughout the lower and middle Smithian.


Inyoites oweni
Xenoceltites Intermontanus
Wyomingites arnoldi

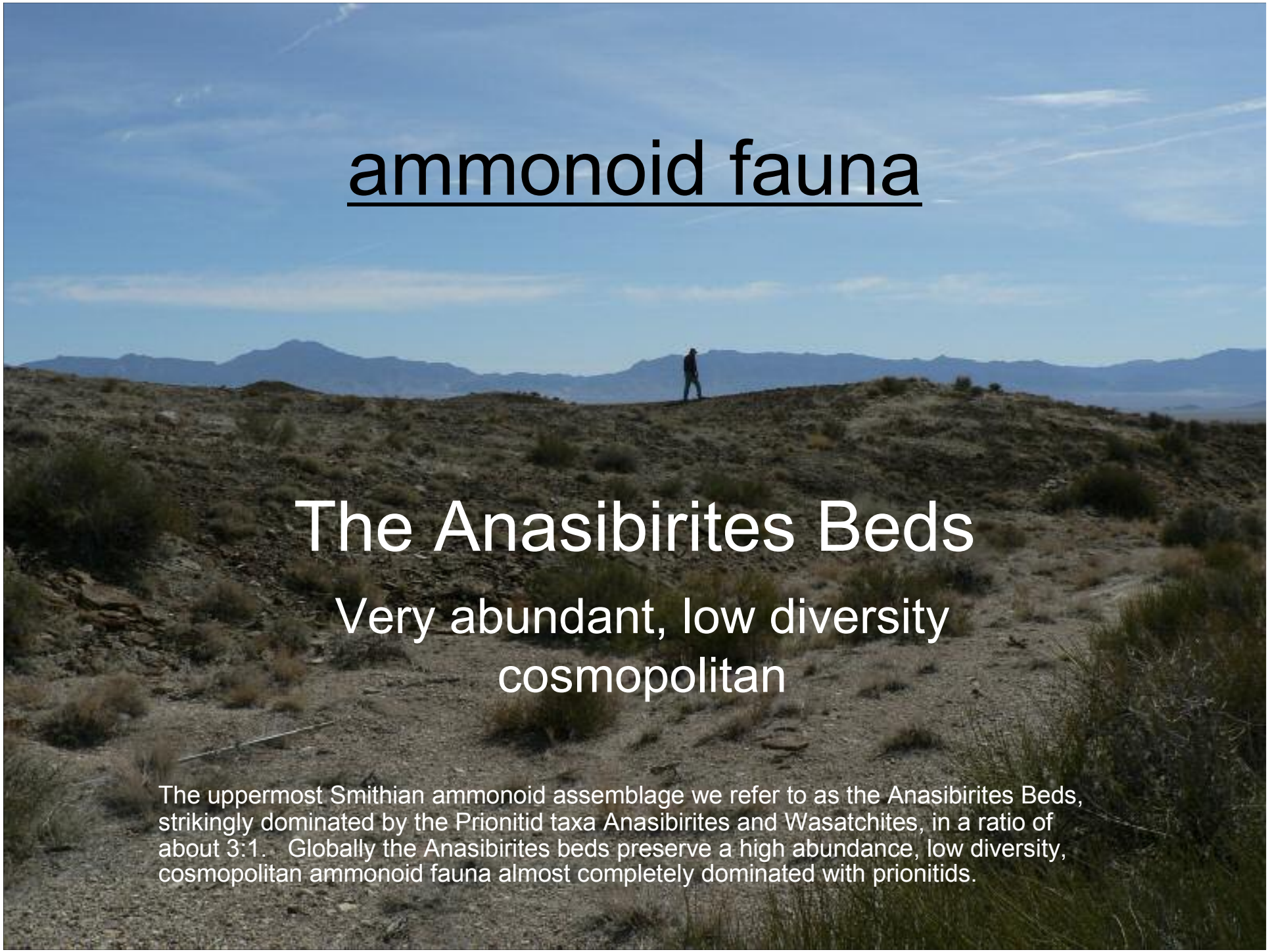

Churkites sp.
Inyoites oweni
5 cm


Guodunites sp.

Pseudosageceras multilobatum


Juvenites septentrionalis


Lanceolites compactus

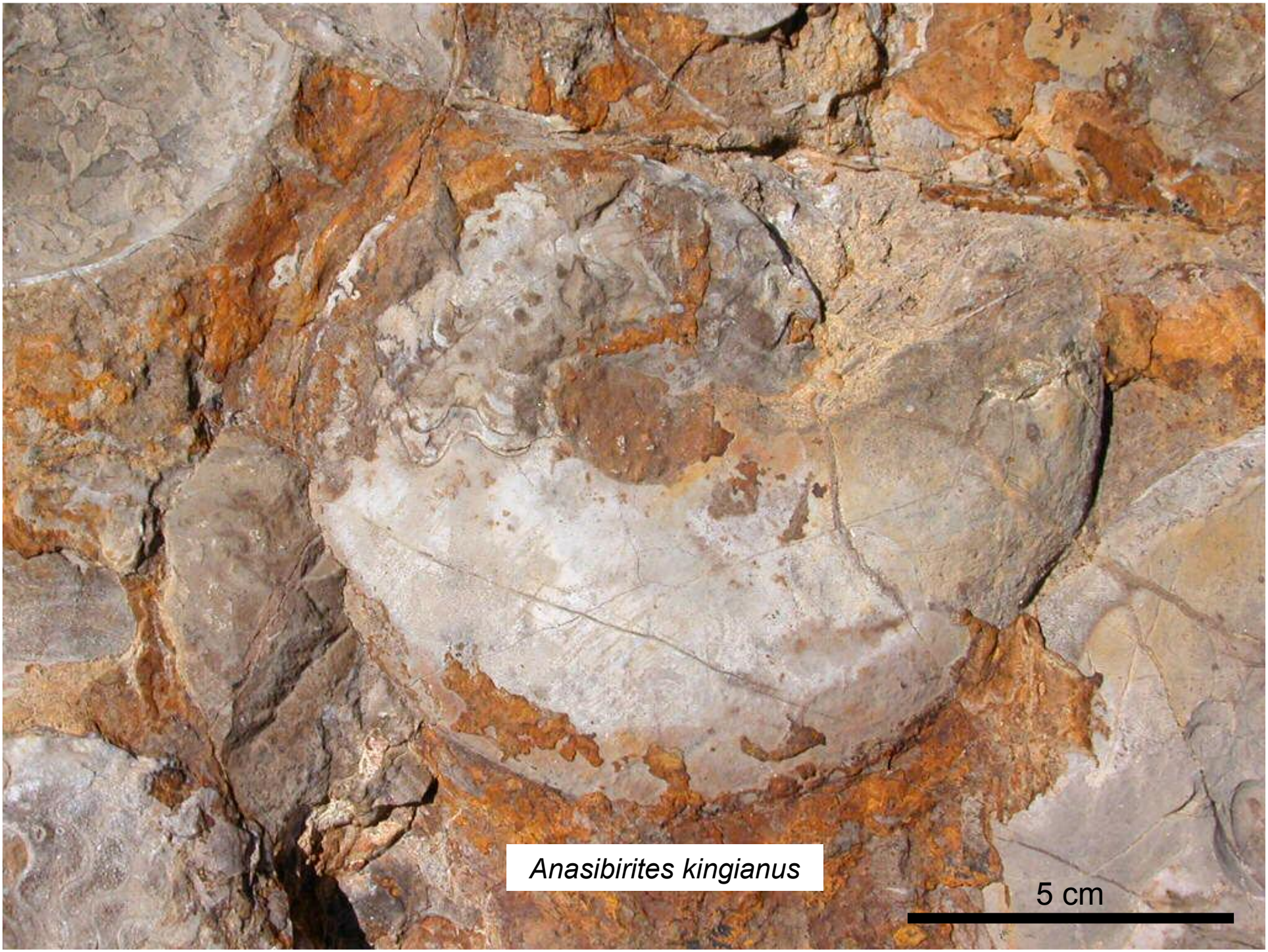


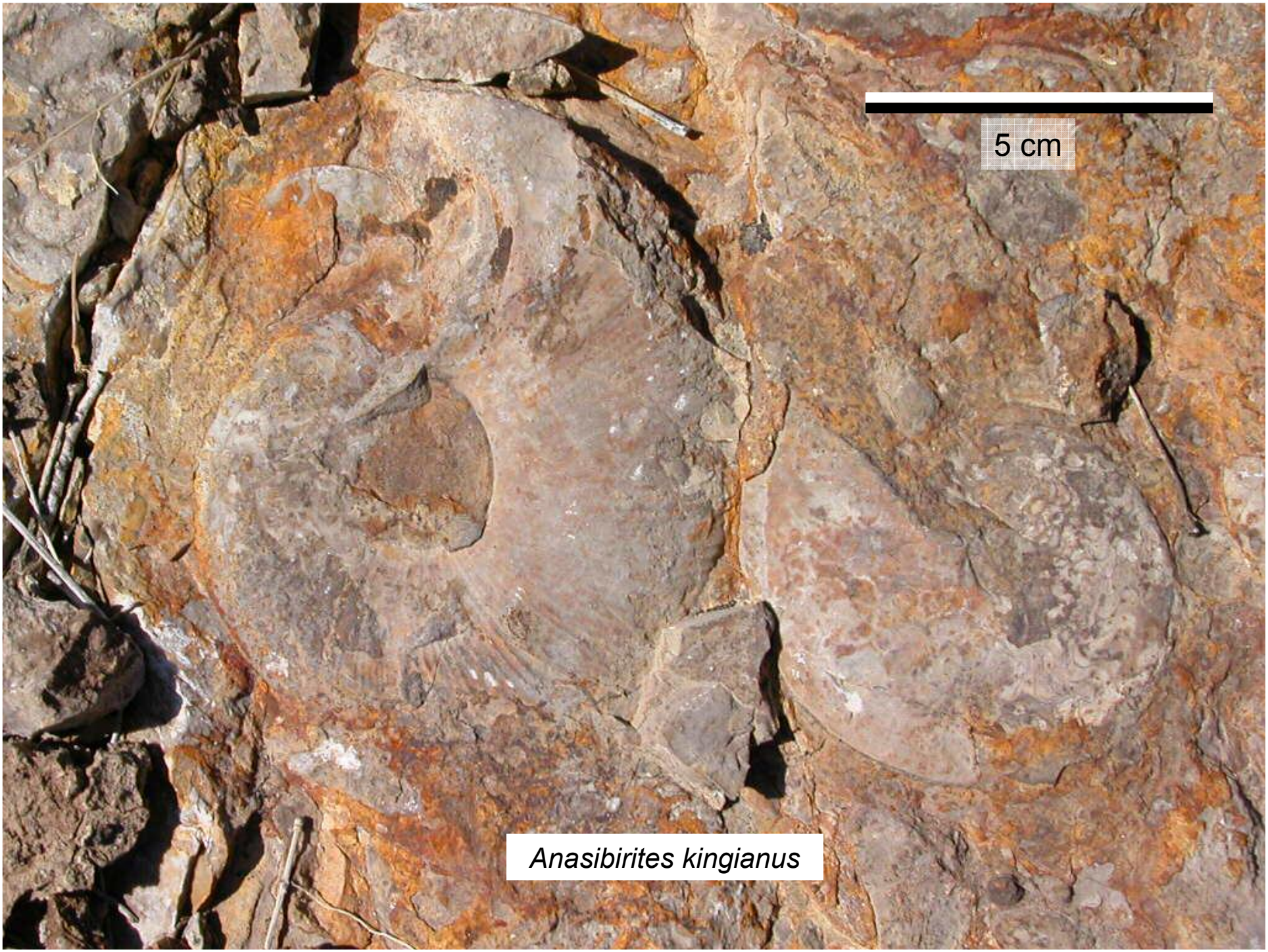
ammonoid fauna

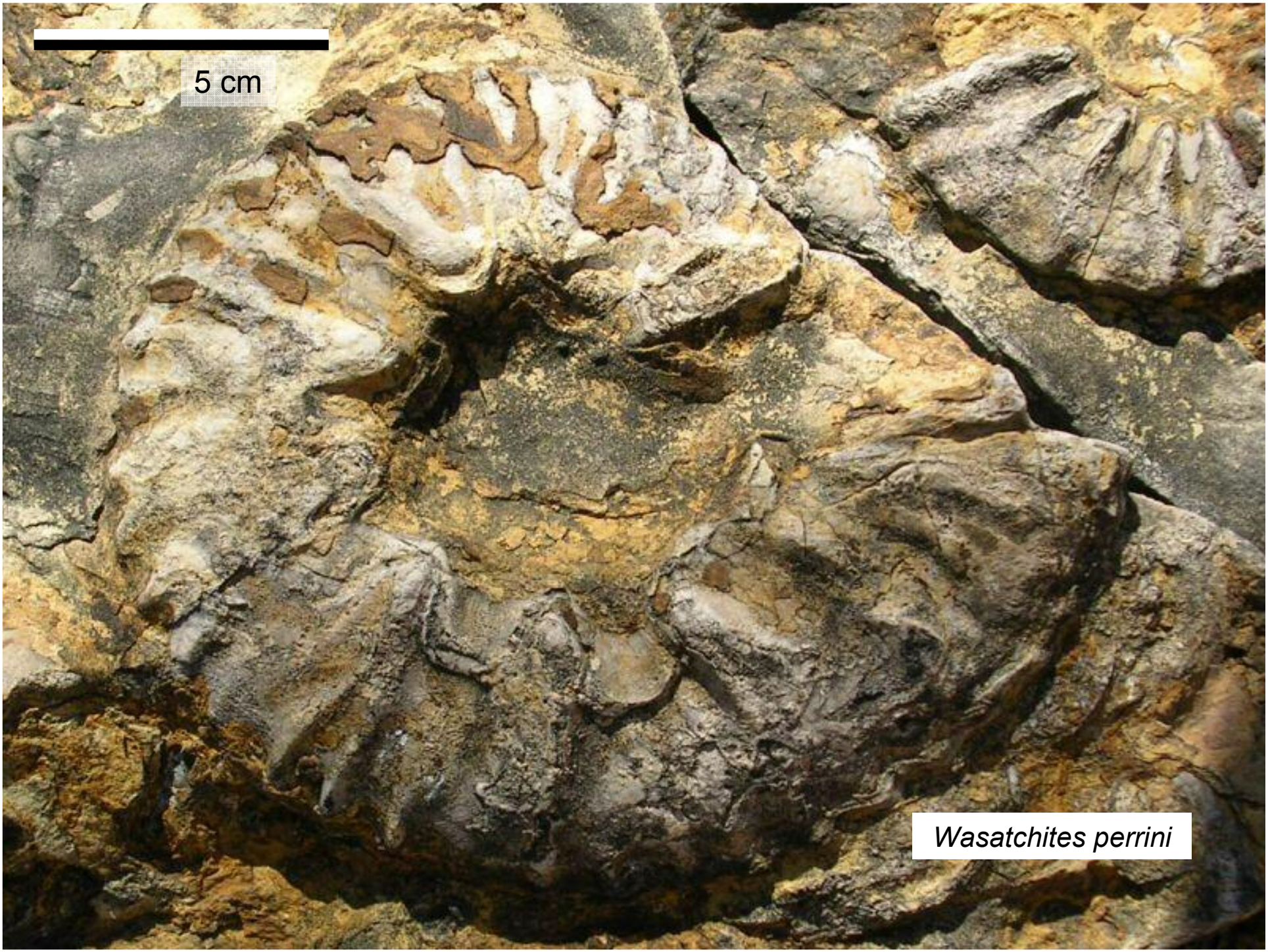
The Anasibirites Beds

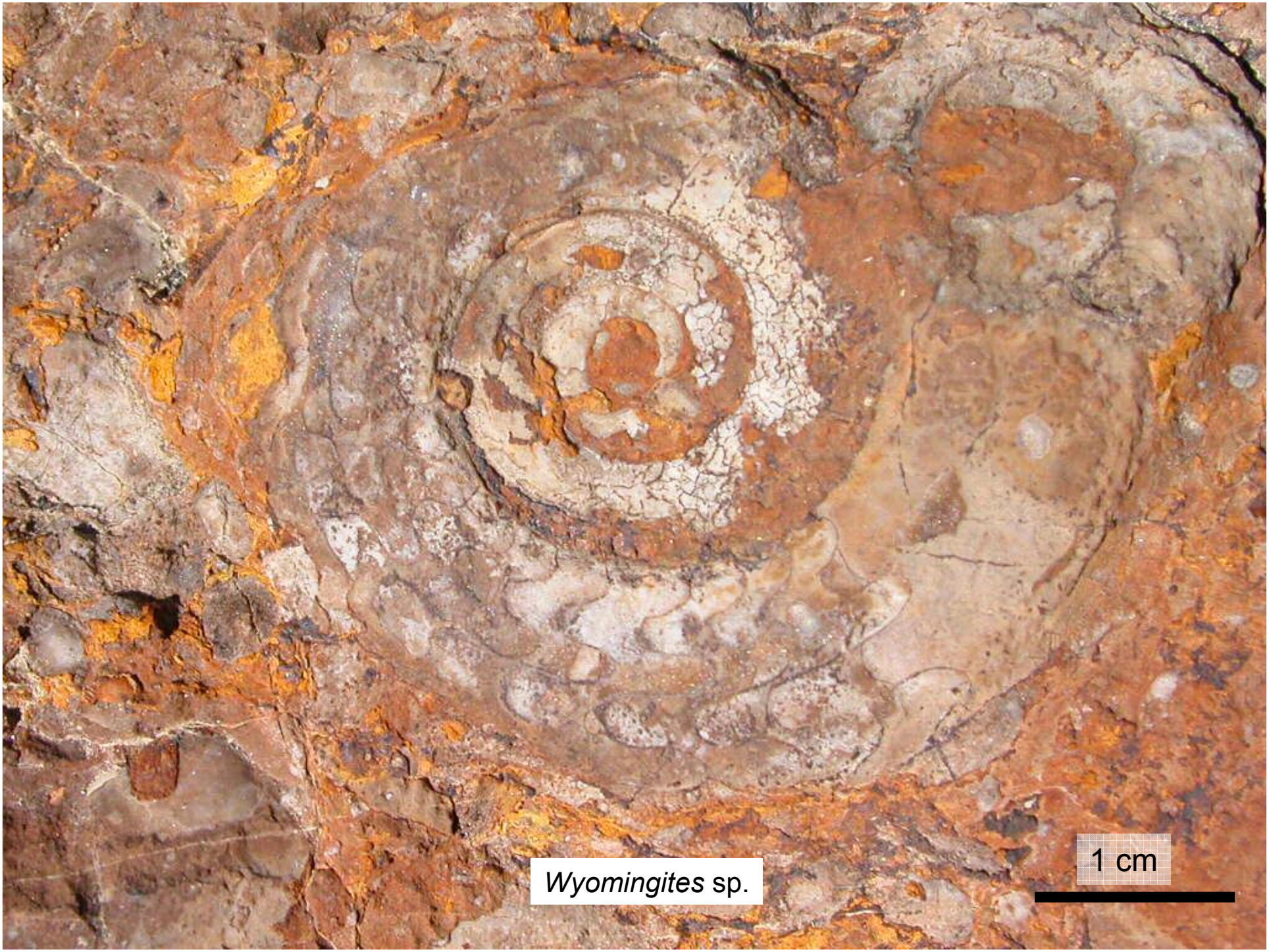
Very abundant, low diversity cosmopolitan

The uppermost Smithian ammonoid assemblage we refer to as the Anasibirites Beds, strikingly dominated by the Prionitid taxa Anasibirites and Wasatchites, in a ratio of about 3:1. Globally the Anasibirites beds preserve a high abundance, low diversity, cosmopolitan ammonoid fauna almost completely dominated with prionitids.


Anasibirites kingianus
5 cm


5 cm
Anasibirites kingianus

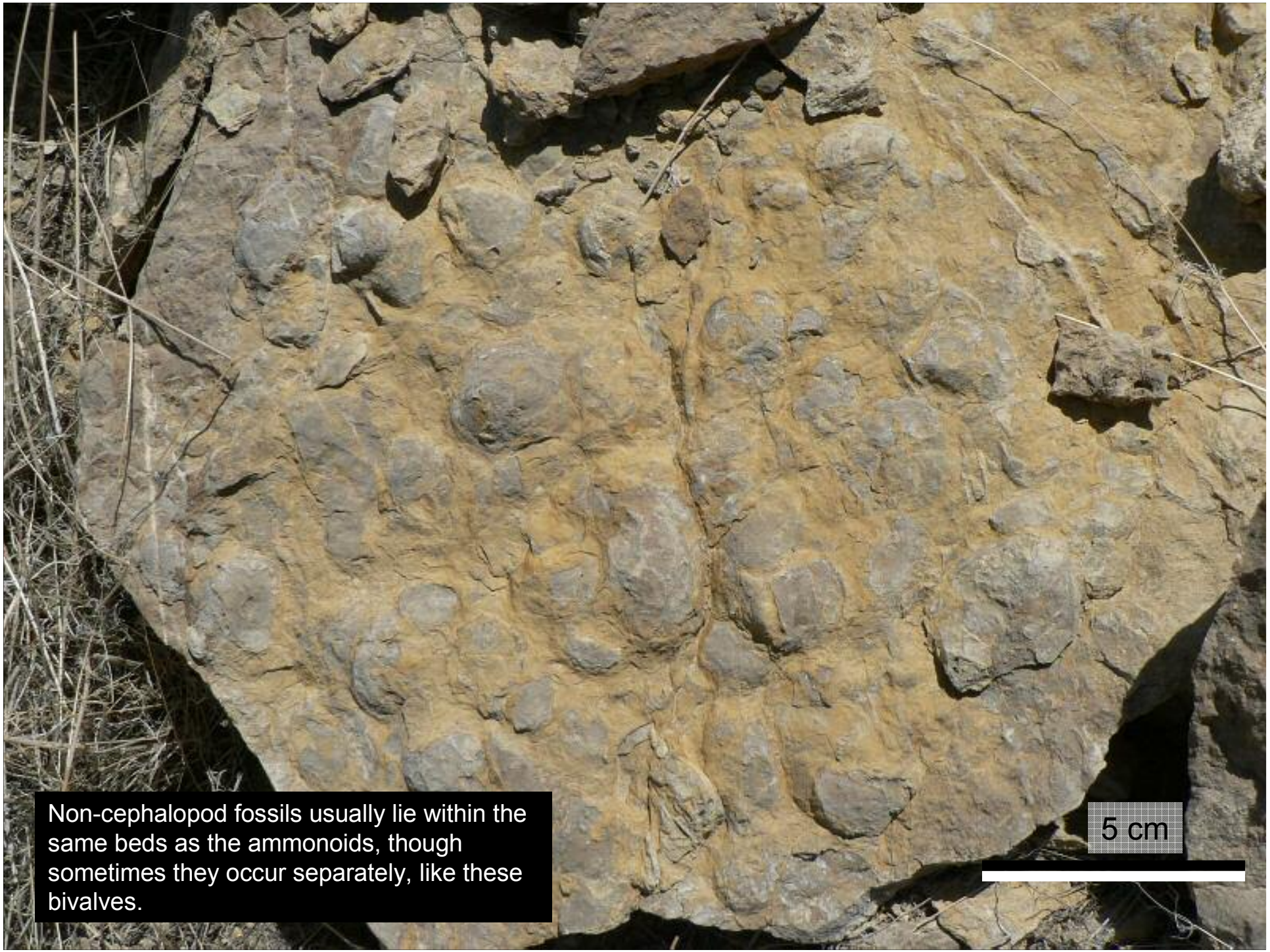

5 cm
Wasatchites perrini


Wyomingites sp.
1 cm

Series		Stage		Paleoequatorial Zone	Mid & High Paleolatitude Zone
Lower Triassic	248 mya	Olenekian	Spathian	Neopopanoceras haugi	Subrobustus
				Prohungarites-Subcolumbites Beds	Pilaticus
				Columbites-Tirolites beds	
	250 Mya		Smithian	Anasibirites Beds	Tardus
				Meekoceras gracilitatis	Romunderi
	251 mya	Induan	Dienerian		
	252 mya		Griesbachian		

Based on our analysis of the ammonoid fauna, there's no doubt that we're in the Smithian Stage of the Lower Triassic. Furthermore, we believe the lower and middle assemblages in the Thaynes Formation fall within the paleoequitorial Meekoceras gracilitatis Zone and the upper assemblage falls within the paleoequitorial Anasibirites Beds.

Most of the limestone beds in the Thaynes Formation of western Utah contain abundant ammonoids, as well as the occasional rare nautiloid. The associated non-cephalopod fauna consists mostly of bivalves and gastropods, like these.


Non-cephalopod fossils usually lie within the same beds as the ammonoids, though sometimes they occur separately, like these bivalves.
5 cm

The associated non-cephalopod fauna is sporadic (like the ammonoid occurrences), and is characterized by high abundance and low diversity. The little white specks in this photo are tiny snails.

Here's a closer look at 'em. This is a sample from the Inyoites Beds where they are particularly conspicuous.

Here are some Pentacrinus crinoid columnals nestled inside a cephalopod living chamber.

We find a few bone fragments like this one. Also seen are some cephalopods and some little bivalves. In general, the associated fauna we see in the Thaynes Formation are typical of "recovery" faunas.

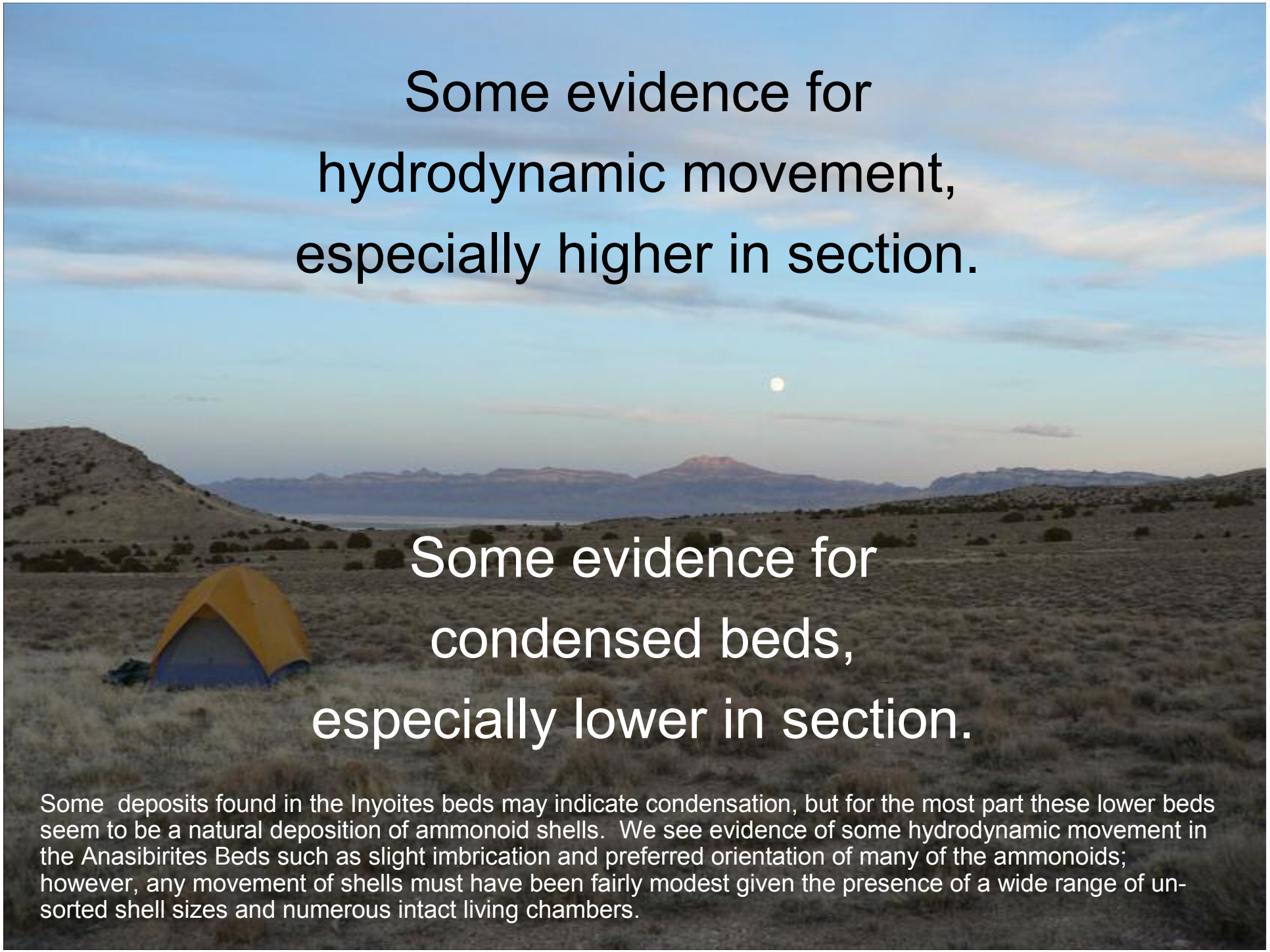
possible causes of ammonoid shell beds

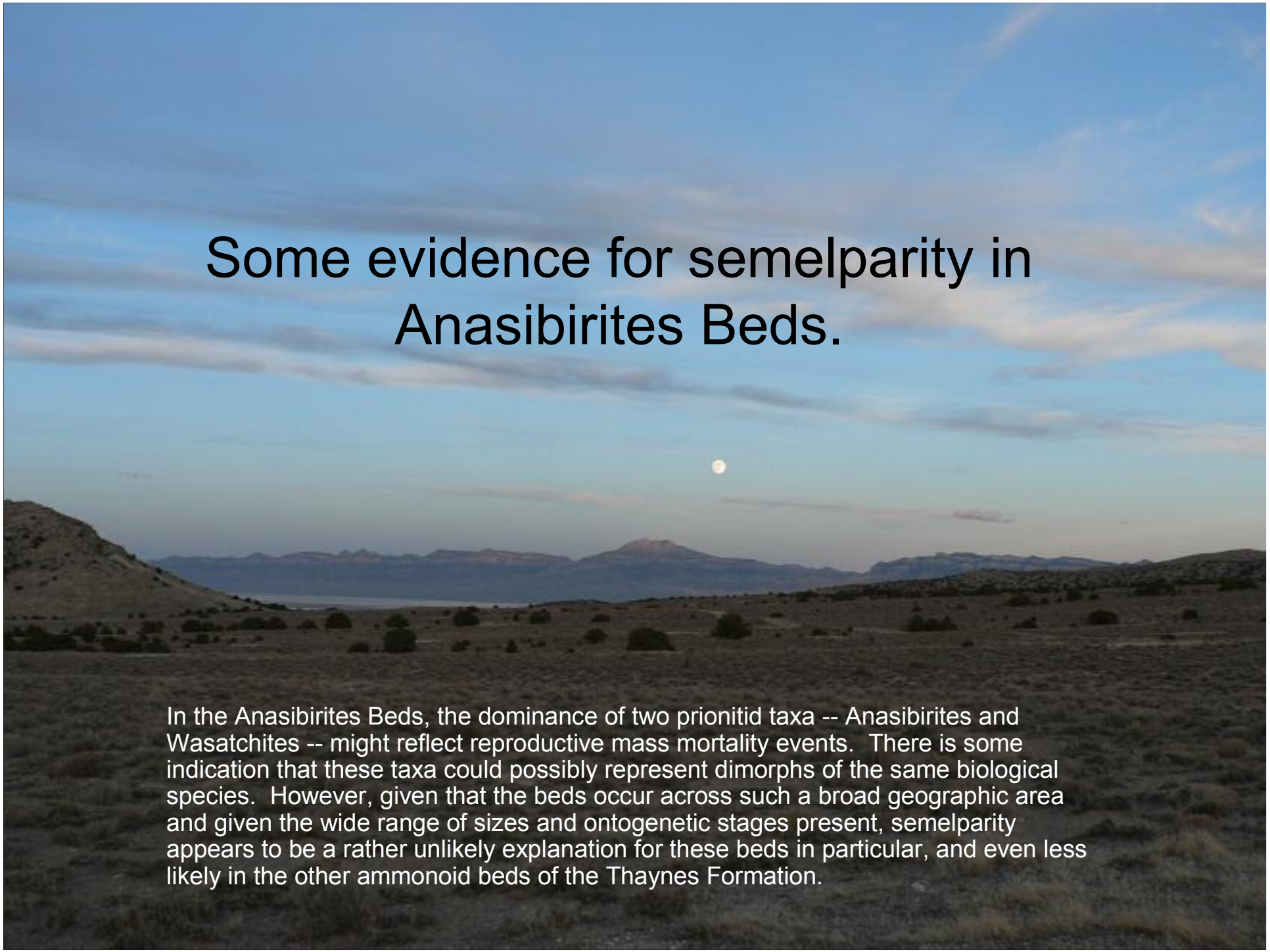
Artificial: Condensed beds, hydrodynamic sorting

Biological: Semelparity, faunal abundance

Environmental: environmental catastrophe

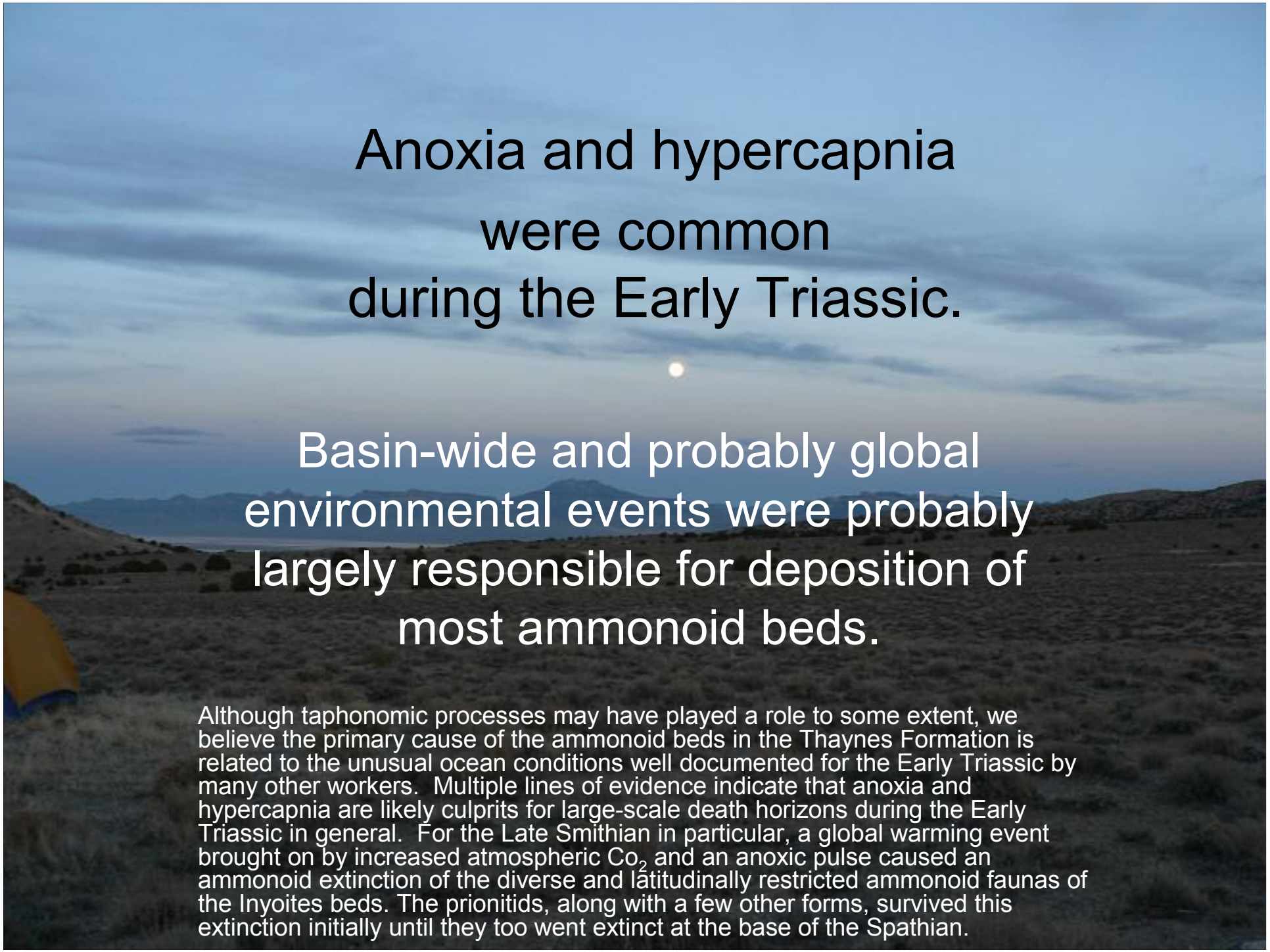
The ammonoid beds we see in the Thaynes Formation might be explained several ways, which might be classified as artificial, biological, and environmental processes. The dense concentrations of ammonoids might have been generated by taphonomic biases, condensed intervals, or post-mortem hydrodynamic transportation, faunal abundance, reproductive mass mortality (semelparity), or, mass mortality caused by environmental catastrophe. There is some evidence that each of the aforementioned causes may have played a role.


Some evidence for
hydrodynamic movement,
especially higher in section.
Some evidence for
condensed beds,
especially lower in section.
Some deposits found in the Inyoites beds may indicate condensation, but for the most part these lower beds seem to be a natural deposition of ammonoid shells. We see evidence of some hydrodynamic movement in the Anasibirites Beds such as slight imbrication and preferred orientation of many of the ammonoids; however, any movement of shells must have been fairly modest given the presence of a wide range of un-sorted shell sizes and numerous intact living chambers.



Some evidence for semelparity in Anasibirites Beds.

In the Anasibirites Beds, the dominance of two prionitid taxa -- Anasibirites and Wasatchites -- might reflect reproductive mass mortality events. There is some indication that these taxa could possibly represent dimorphs of the same biological species. However, given that the beds occur across such a broad geographic area and given the wide range of sizes and ontogenetic stages present, semelparity appears to be a rather unlikely explanation for these beds in particular, and even less likely in the other ammonoid beds of the Thaynes Formation.


Anoxia and hypercapnia
were common
during the Early Triassic.
Basin-wide and probably global
environmental events were probably
largely responsible for deposition of
most ammonoid beds.
Although taphonomic processes may have played a role to some extent, we believe the primary cause of the ammonoid beds in the Thaynes Formation is related to the unusual ocean conditions well documented for the Early Triassic by many other workers. Multiple lines of evidence indicate that anoxia and hypercapnia are likely culprits for large-scale death horizons during the Early Triassic in general. For the Late Smithian in particular, a global warming event brought on by increased atmospheric Co_2 and an anoxic pulse caused an ammonoid extinction of the diverse and latitudinally restricted ammonoid faunas of the Inyoites beds. The prionitids, along with a few other forms, survived this extinction initially until they too went extinct at the base of the Spathian.

Thank You

I'd like to thank Dr. Dan Stephen of UVSC for inviting me to participate in this study

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