A PROMINENT SEISMITE IN THE UPPER CRETACEOUS LANCE FORMATION IN NORTHEASTERN WYOMING AS A STRATIGRAPHIC MARKER

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Abstract

The Lance Formation is notoriously difficult to decipher stratigraphically, as most sedimentary features are transient and the most apparent horizons are diagenetically altered beds that are not reliably traceable over distance. While mapping a series of rich bonebeds in the upper Lance Formation in the eastern limb of the Powder River Basin of northeastern Wyoming, we encountered a two meter thick bed of tan sandstone that consistently revealed characteristics of a seismite. The unit showed pervasive meter scale chaotically displaced bedding, flame structures and features characteristic of rapid dewatering. The overlying and underlying units of similar crossbedded sandstone showed no alteration of original bedding structure. This bed was traced continuously in outcrop for distances of up to a kilometer at several locations over 50 square km. This has enabled us to derive an accurate regional dip for the Lance in this area.

Using this seismite as a datum, we were able to successfully develop a stratigraphic framework for the area containing the bonebeds of interest. One of these bonebeds, 15 meters below the seismite horizon thus far has yielded Edmontosaurus, Struthiomimus and Triceratops bones, as well as abundant gar scales, numerous teeth of theropod and ornothopod dinosaurs and turtle fragments and crocodile scutes typical of Lancian "microsites". Our major bonebed, occurring 29 meters below the seismic horizon, contains the disarticulated remains of more than 15,000 Edmontosaurus in a normally graded bed. This bed can now be mapped with confidence over a wide area. A third prolific bonebed, 38 meters stratigraphically below the seismite, has thus far yielded no remains of Edmontosaurus, but contained disarticulated remains of Pachycephalosaurus, Nodosaurus, Tyrannosaurus, Triceratops, and other dinosaurs and reptiles, including numerous turtles. Other known bonebeds in the area can now be explored in a stratigraphic context.

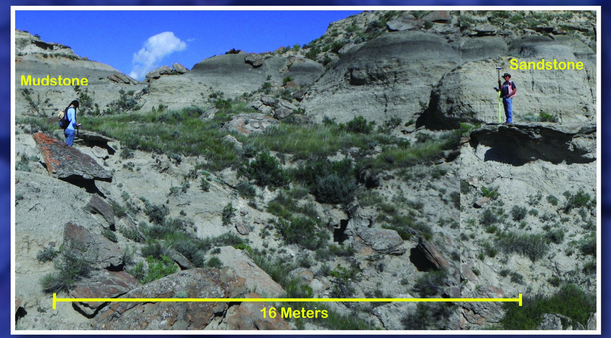

Fig. 1. Typical outcrop of the Lance Formation in northeastern Wyoming. On the right side of the picture the outcrop is sandstone. On the left it is siltstone and claystone.

Fig. 2. An outcrop from the Lance Formation illustrating the problem with tracing benches. The diagenetic carbonate cementation provides an illusion of traceable bedding.

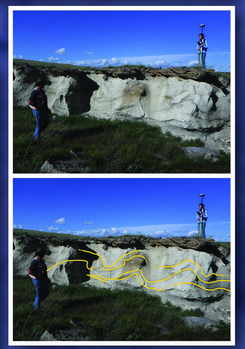

Fig. 3. Seismite layer in outcrop. The yellow lines in the lower figure indicate the traces of select bedding surfaces in outcrop. The upper figure unmarked for comparison.

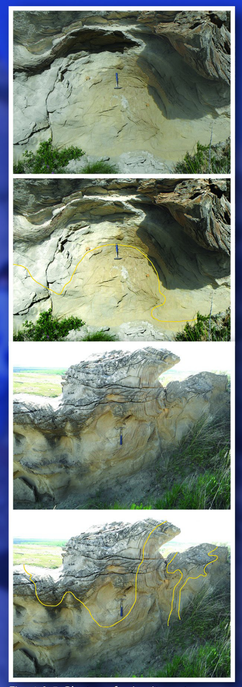

Fig. 4 & 5. Photos of seismite outcrop showing variations in degree of convolution as well as slump folds.

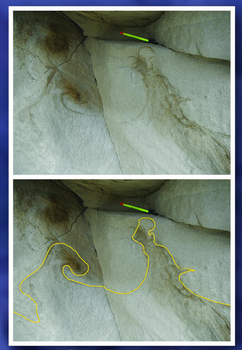

Fig. 6. Pen for scale; image exhibits minor flame structures as well as overturned convolute structures.

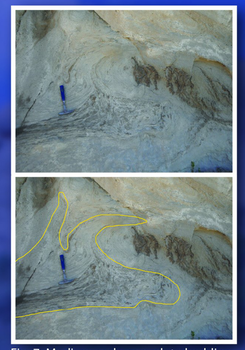

Fig. 7. Medium scale convolute bedding displaying large scale flame structures.

Fig. 8. Sharp angles on large flame structures, suggesting proximity to fault zone.

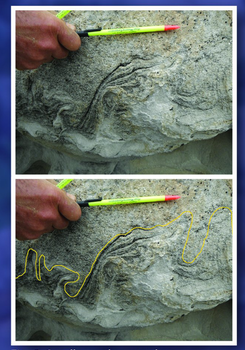

Fig. 9. Smaller scale convolute laminations in seismically disturbed, water-saturated sandstone.

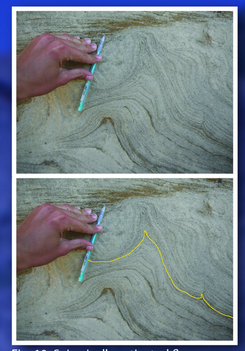

Fig. 10. Seismically activated flame structure pervasive through many laminae.

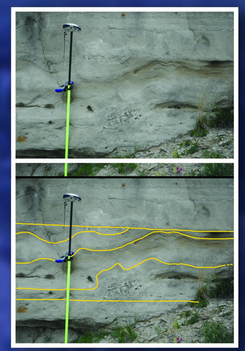

Fig. 11. Sandstone outcrop displaying undisturbed upper and lower contacts with the seismite layer. Note apparent truncation of beds at upper surface.

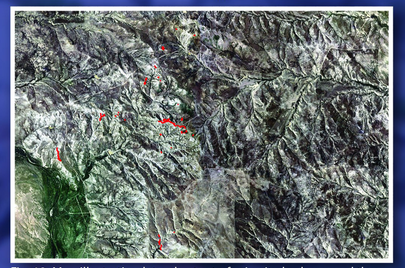

Fig. 12. Map illustrating lateral extent of seismite bed mapped thus far. The full extent of the bed or beds has not yet been determined.

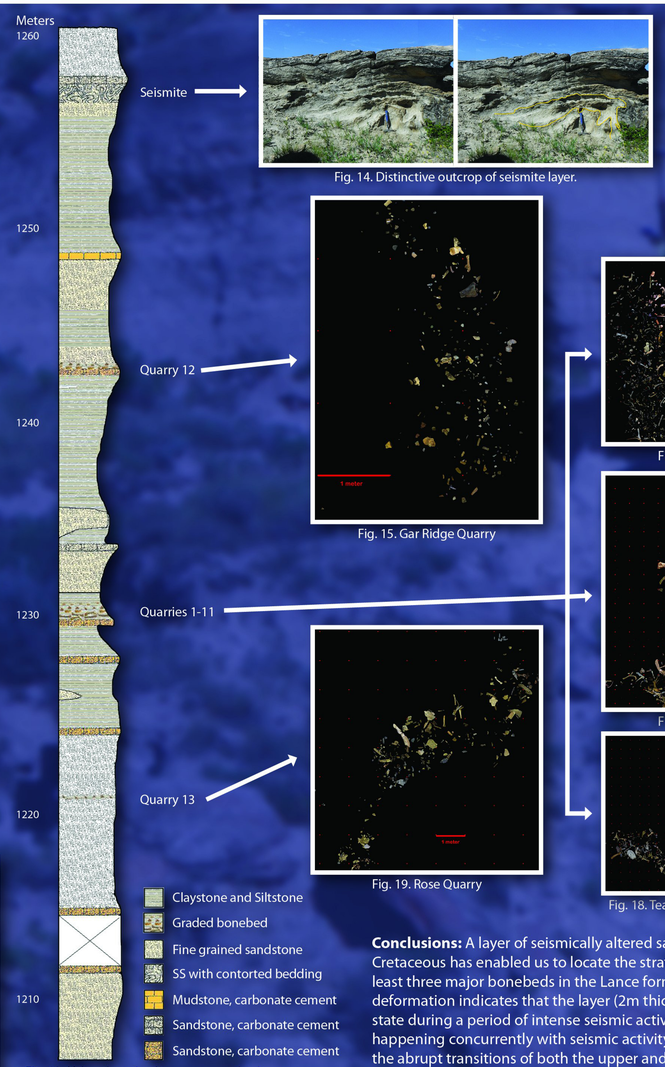

Fig. 13. Using the seismite as an event horizon, we are now able to place our quarries in a stratigraphic sequence. We have thus far mapped three horizons with significant bonebeds. The principal bonebed lies 27 meters below the seismite horizon.

Fig. 14. Distinctive outcrop of seismite layer.

Fig. 15. Gar Ridge Quarry

Fig. 16. North Quarry

Fig. 19. Rose Quarry

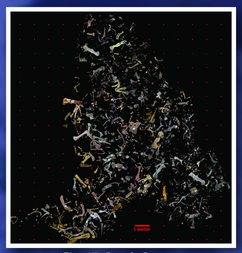

Fig. 17. South Quarry

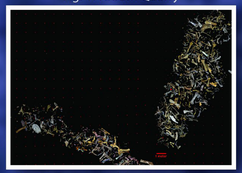

Fig. 18. Teague and Southeast Quarries

Conclusions: A layer of seismically altered sandstone in the Upper Cretaceous has enabled us to locate the stratigraphic positions of at least three major bonebeds in the Lance formation. The nature of the deformation indicates that the layer (2m thick) was in the liquefied state during a period of intense seismic activity. Liquefaction happening concurrently with seismic activity is improbable due to the abrupt transitions of both the upper and lower contacts. These observations are consistent with an episode of rapid sedimentation in deeper water followed closely by a major seismic event. The resultant stratigraphically restricted, widespread layer has enabled us to define a local stratigraphy in this challenging terrain.