Tectonic Deformation of a Late Wolfcampian Carbonate Ramp and Resulting Slope Deposition

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ABSTRACT

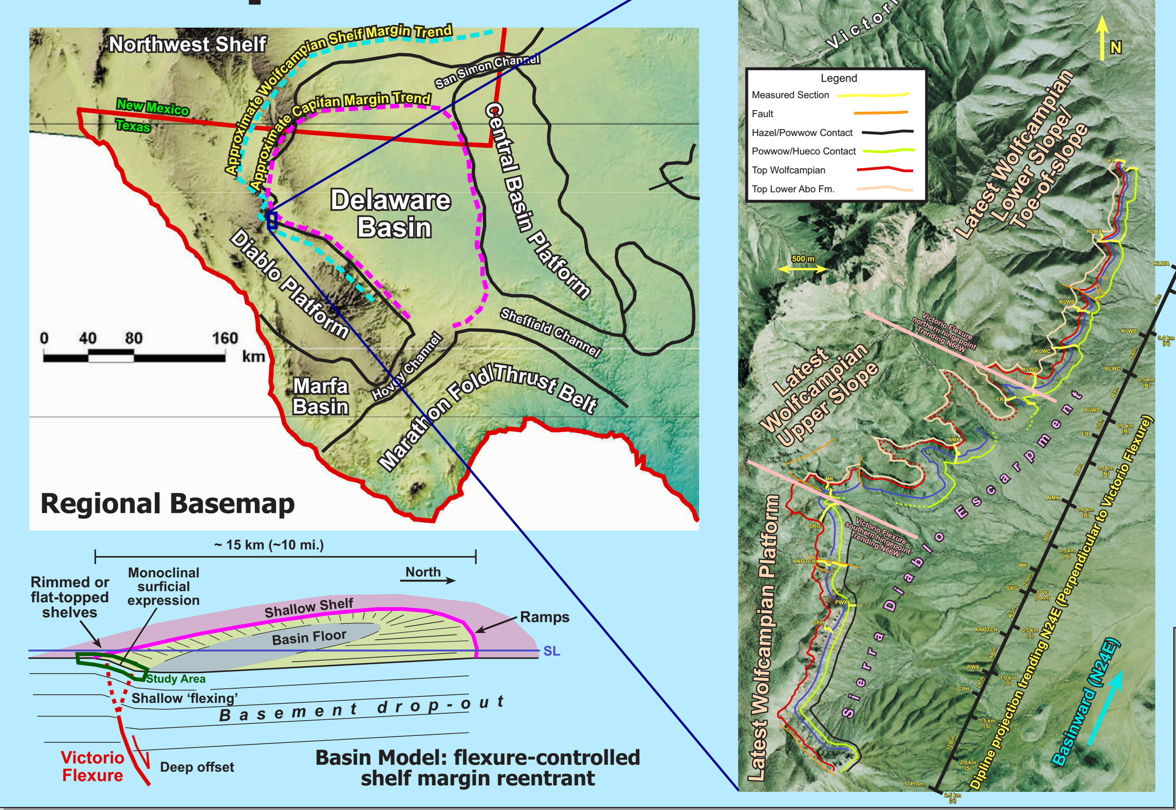
Outcrops in the Victorio Flexure area of the Sierra Diablo Mountains, West Texas, provide evidence that suggest 1.) Ouachita-related tectonism remained active throughout early Permian time (Wolfcampian) in the Delaware Basin, and 2.) line-sourced, carbonate debris aprons can be composed of amalgamated, point-sourced channel elements. The Victorio Flexure is a deep-rooted structure that reactivated during late Paleozoic deformation, forming a WNW-ESE trending monoclinal feature with a down-to-the-north sense of motion and WNW-ESE trending northern and southern hingepoints expressed at the surface. In the lower Permian (Wolfcampian), uplifted strata south of the Victorio Flexure were eroded and were the source for clastic alluvial and fluvial systems (Powwow Formation). Marine transgression followed and flooded the landscape, clastic influx waned, and carbonate production ensued. Distal outer ramp and basin floor wackestones/packstones were initially deposited during transgression followed by the accumulation of shallower outer ramp packstones as sea level stabilized (lower to upper Hueco 'C' Formation). The progradational extent of the outer ramp sediments coincides with the position of the southern hingepoint of the Victorio Flexure and is reflected as a subtle break in slope. This carbonate depositional profile can be characterized as a structurally-modified, distally steepened ramp.

In latest Wolfcampian time, significant northward rotation of the Victorio Flexure monocline increased slope height by over 170 m and slope gradient by more than 6°. This displacement triggered the slumping of outer ramp, distal outer ramp, and basin floor sediments. Sandier outer ramp facies detached along flooding surfaces and deformed coherently as distinct slump masses at the newly defined upper slope position. Muddier, distal outer ramp and basin floor facies disaggregated upon slumping and resedimented to form a non-channelized, debris flow apron at the new lower slope position. Flow hierarchy and axial-to-flank relationships are evident internally. This tectonically-driven rearrangement of the depositional profile marks the terminal event in the Wolfcampian.

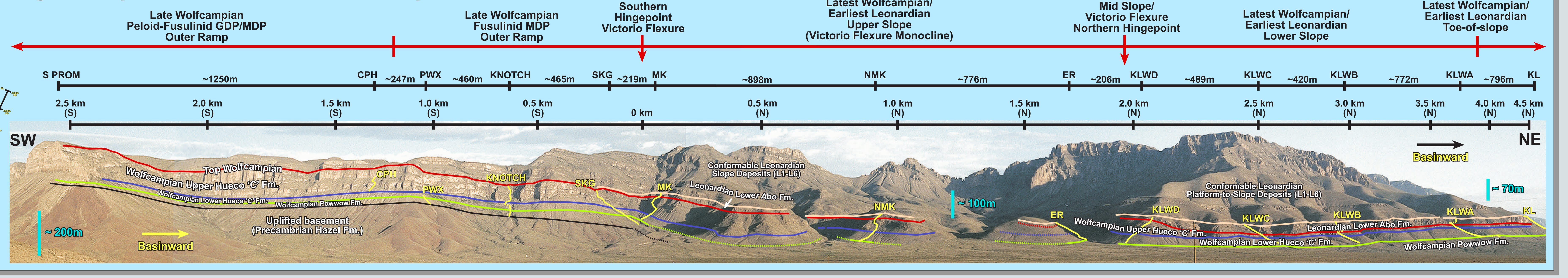
Ramp margin reentrants at the southern hingepoint of the Victorio Flexure, developed from the late Wolfcampian tectonic event, funneled early Leonardian carbonate material downslope from an unknown updip source. Allochthonous debris bypassed the upper slope and ponded at the lower slope position in the form of amalgamated channel complexes. Channel complexes are filled with compensationally stacked debris flows that display hierarchical organization. Notable proximal-to-distal changes are observed in channel attributes, such as degree of incision, aspect ratio, and mounding. High- and low-concentration sediment gravity flows fill in topography between debrite complexes.

Knowledge of late Wolfcampian tectonic activity related to Ouachita deformation provides additional information to constrain the waning of tectonism in the Delaware Basin. Improved carbonate slope models can be developed that emphasize slope channelization and that leverage the similarities between well-understood clastic slopes and less well understood carbonate slopes.

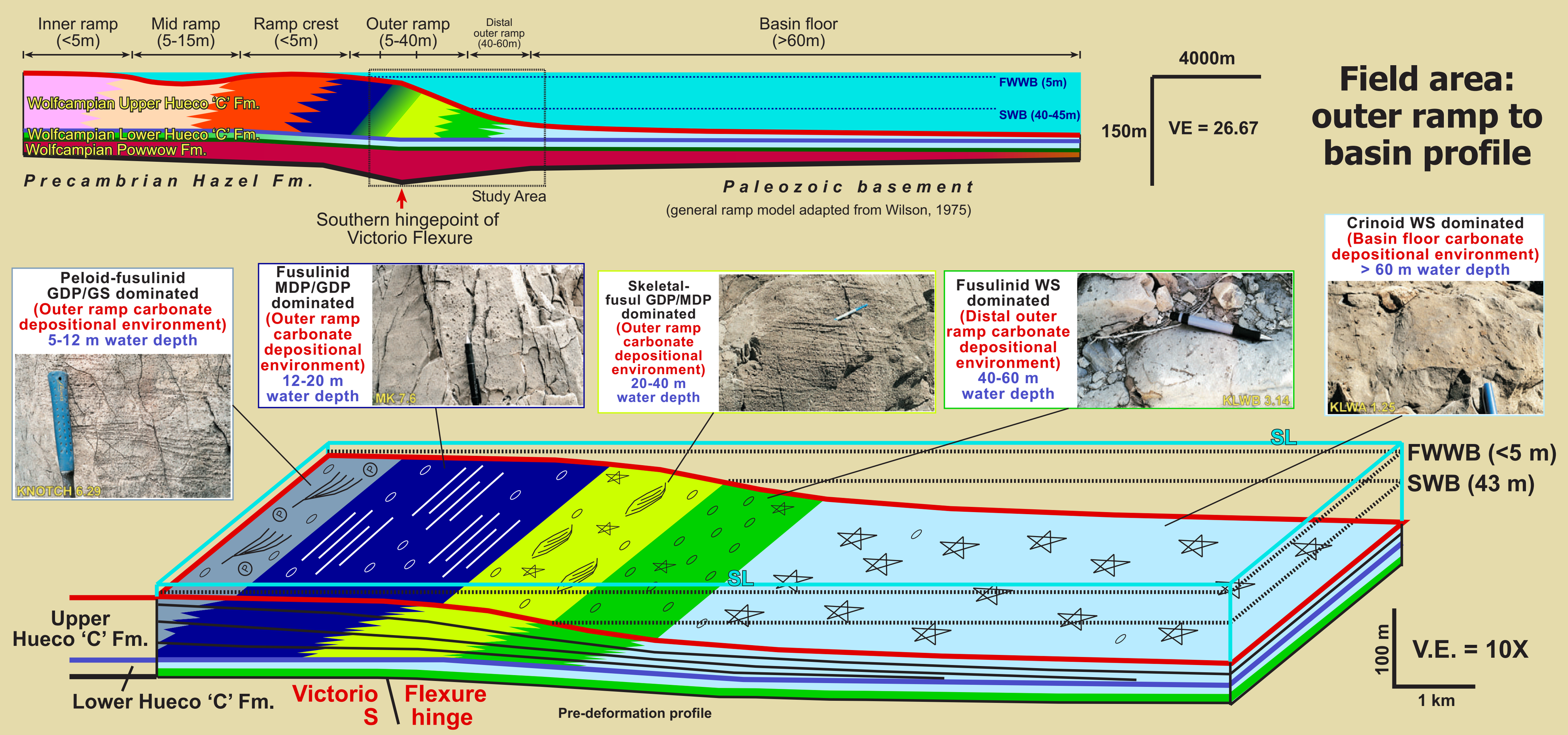
Outcrop Location



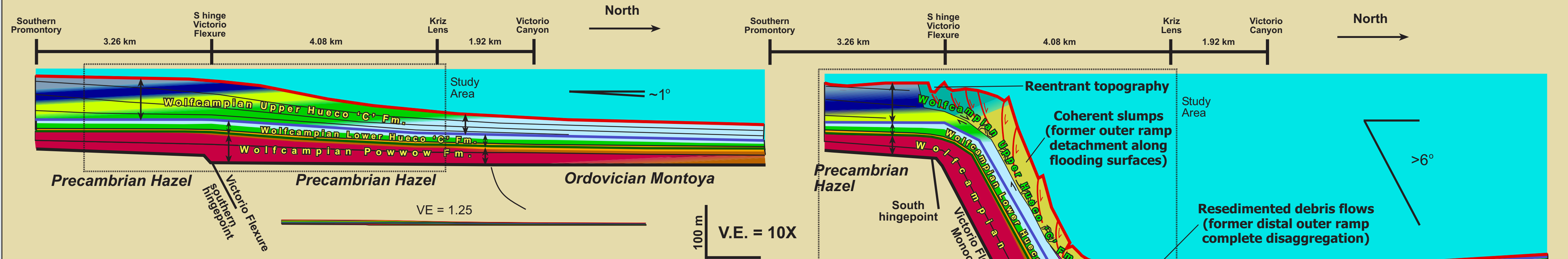
Regional Dip Photomosaic of Field Area Exposure



Late Wolfcampian Hueco 'C' Ramp Deposition

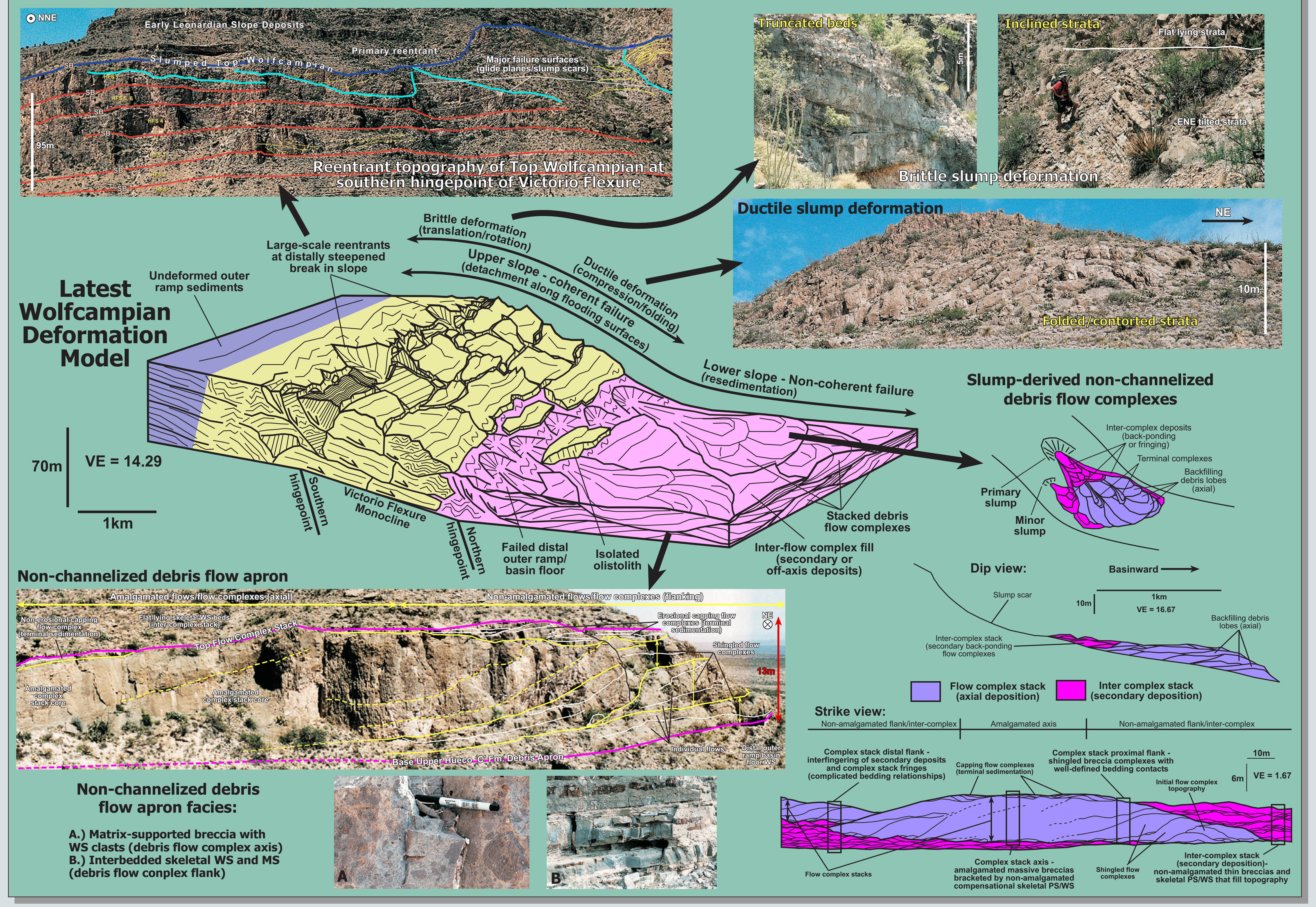


Latest Wolfcampian Tectonic Rotation/Slope Rearrangement

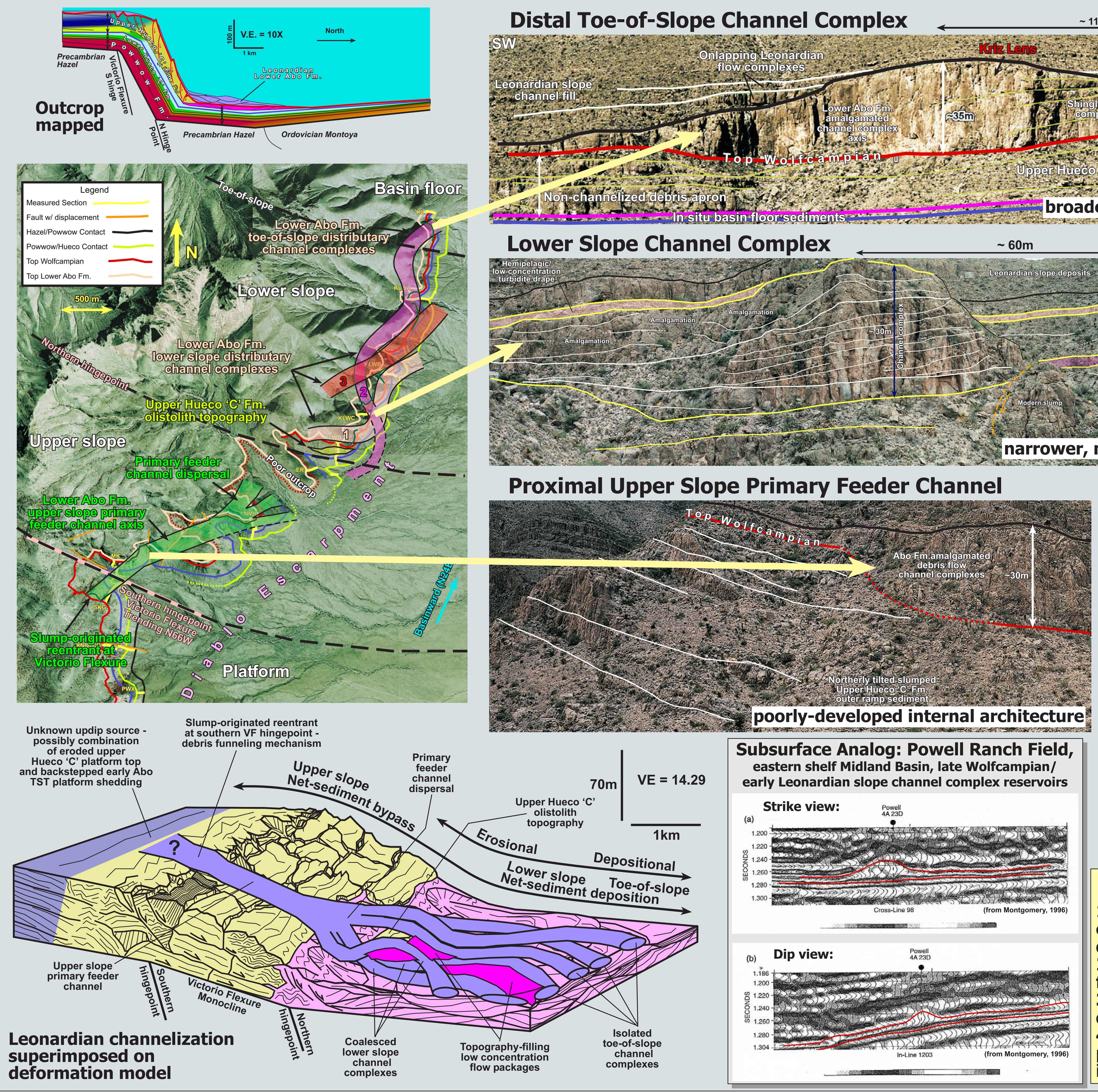


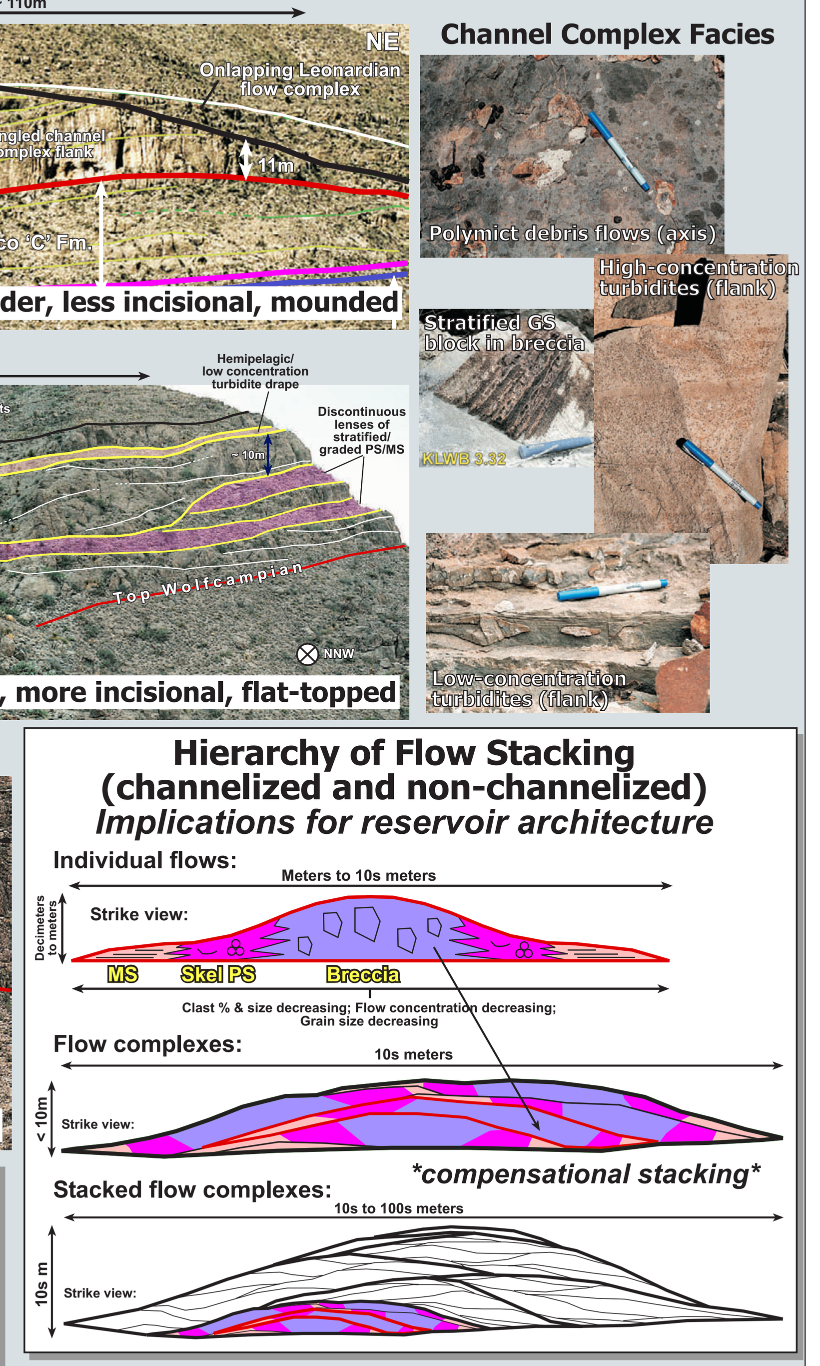
* Northward rotation of Victorio Flexure monocline
* Slope height increase of ~ 170m
* Slope gradient increase of ~ 6 degrees
* Significant reentrant topography created at southern hingepoint
* Coherent failure of previous outer ramp
* Non-coherent failure of previous distal outer ramp

Hueco 'C' Response to Latest Wolfcampian Tectonic Rotation Along the Victorio Flexure



Earliest Leonardian Slope Channelization Via Margin Reentrants





Conclusions for Reservoir Prediction

1.) Channel as well as sheet architectural elements can be a significant component of carbonate slope debris accumulations
2.) Carbonate slope channelization requires an updip focussing mechanism (i.e. reentrants)
3.) Internal stacking architecture within carbonate debris complexes can be similar to clastic architecture
4.) Carbonate slope channel complexes can display proximal-to-distal transitions similar to those described in clastic slope models