Structural and Stratigraphic Investigations, Gilead Sandstone and Associated Units

Albian – Turonian Strata
Ivishak River – Gilead Creek area

Progress During 2007

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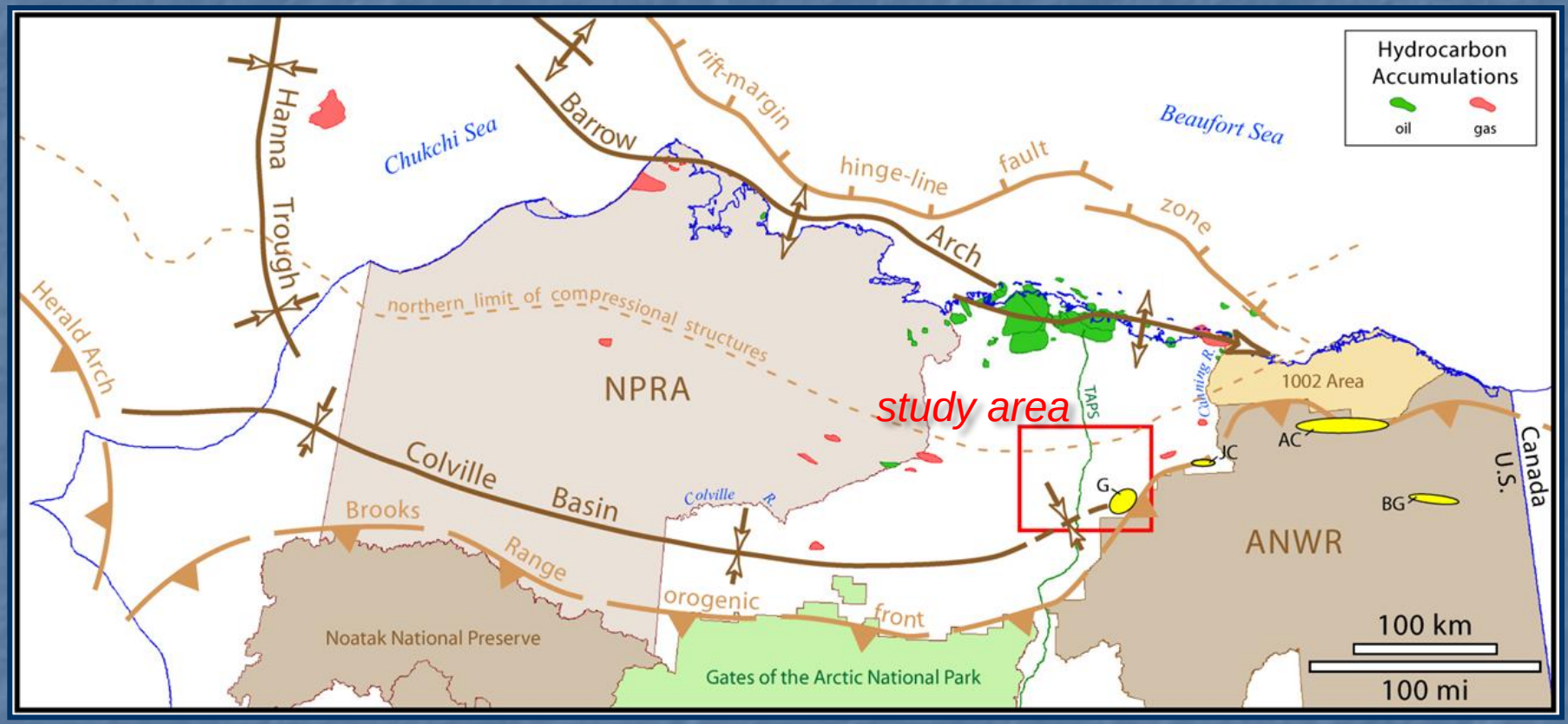
Northern Alaska Tectonic Elements



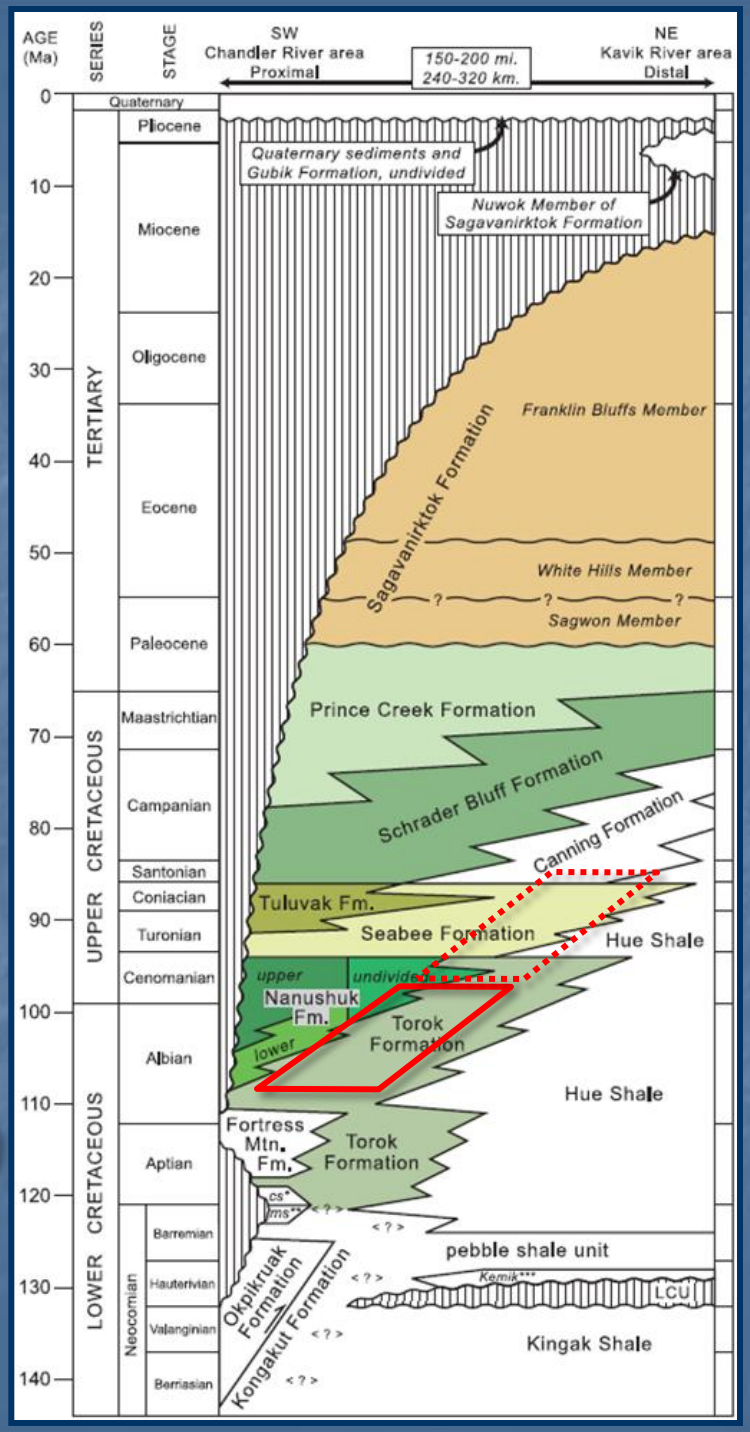
Brookian Stratigraphy

(redefined nomenclature of Mull and others, 2003)

Gilead sandstone

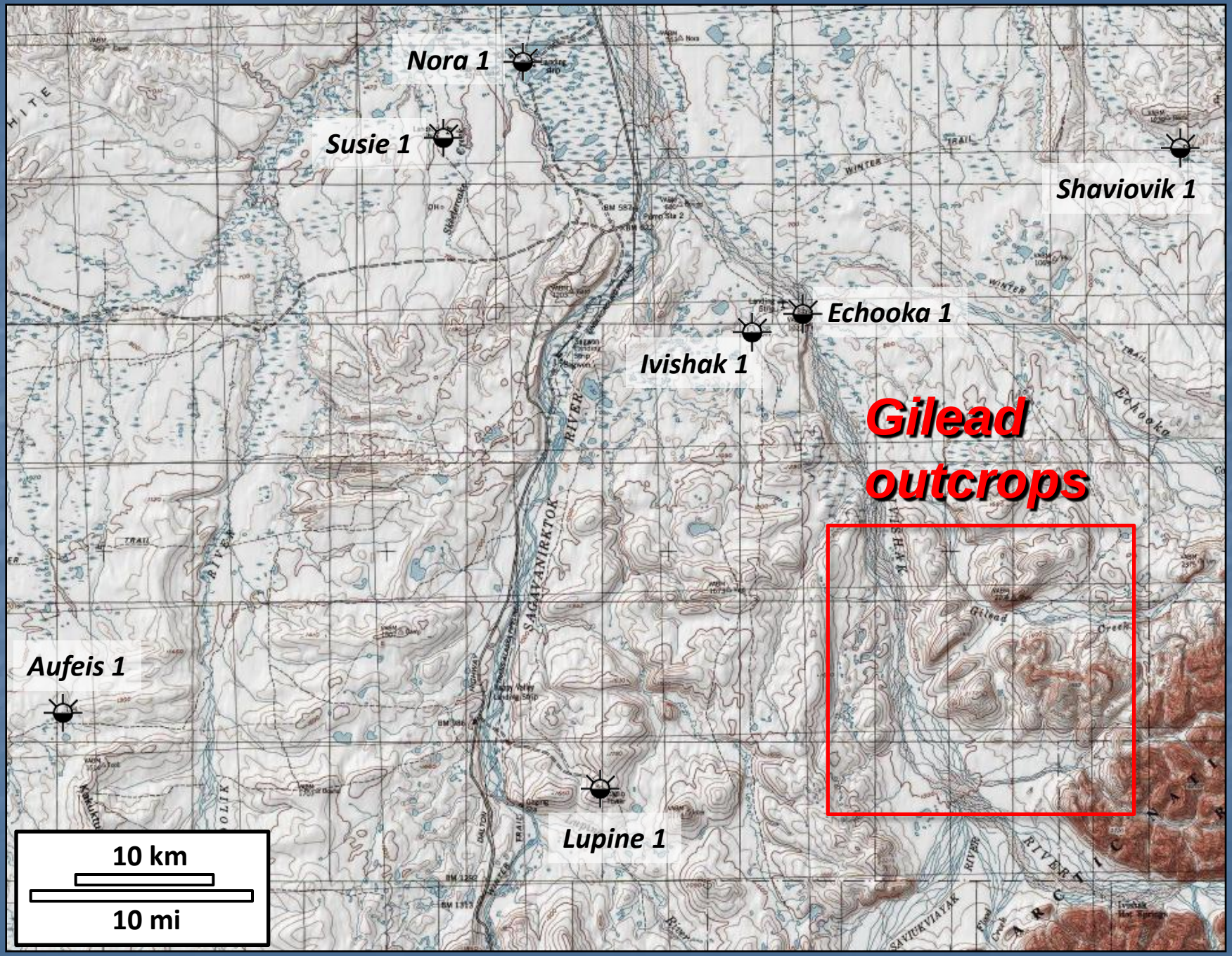
Informal name (Reifenstuhl, 1989; 1991)

- Albian-Cenomanian preserved at Gilead syncline (largely Torok-Nanushuk equivalent, but …)
- Base not exposed (detachment, but ~intact?)
- Genetic top of unit not defined
- Relationship to Seabee Formation unclear
- Tectonically interleaved with Upper Cretaceous

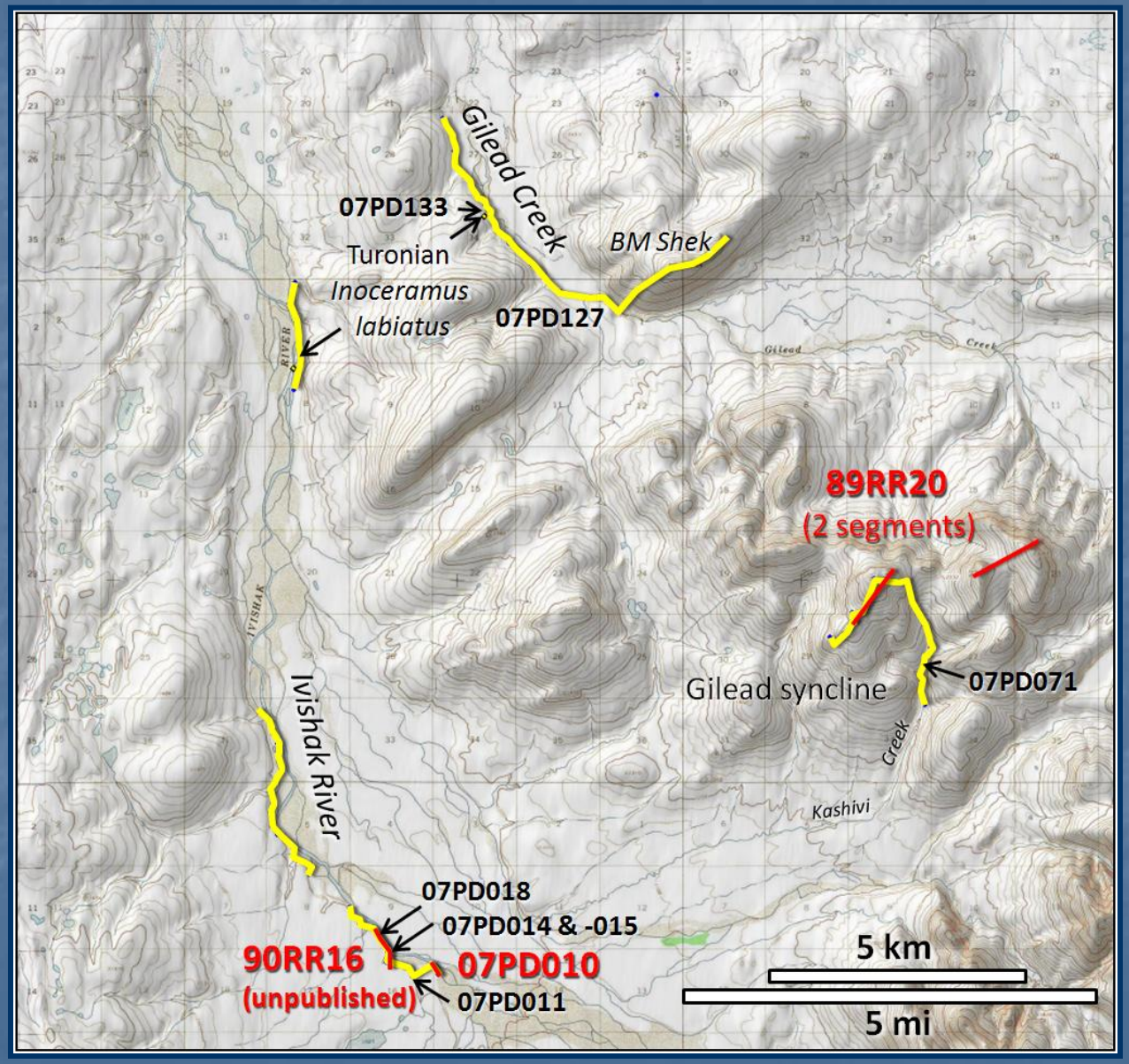


Why study the Gilead succession?

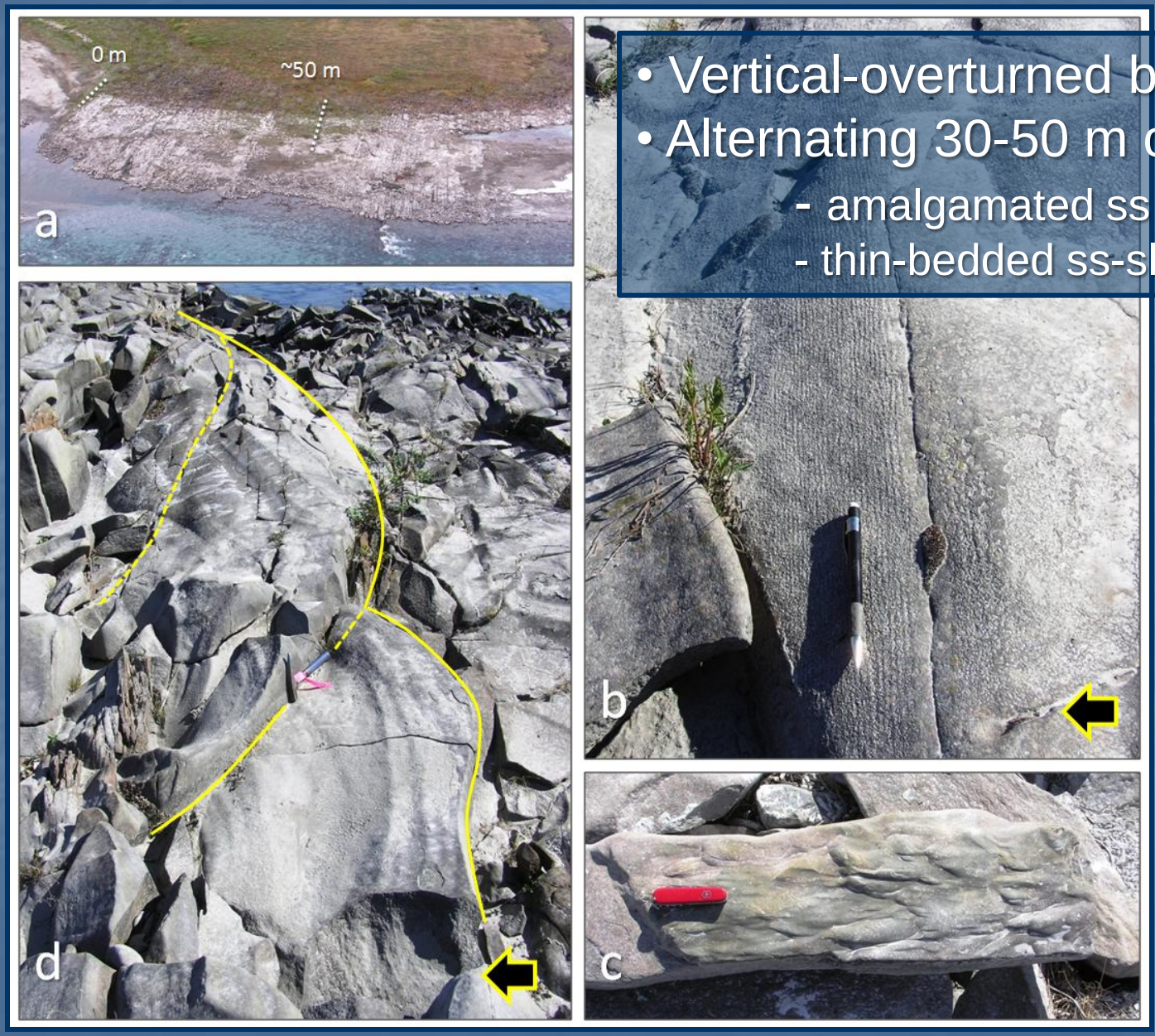
- > 850-m-thick interval of Lower to middle Cretaceous clastics, including thick sandstones
- Unique exposures of deepwater to basin axis facies belt (in subsurface to west, uplifted/eroded to east)
- Enigmatic relationships to underlying and overlying units require clarification for basin reconstructions


Nora 1
Susie 1
Shaviovik 1
Echooka 1
Ivishak 1
Gilead outcrops
Aufeis 1
Lupine 1
10 km
10 mi

Ivishak River, Gilead Syncline, Gilead Creek



2007 Gilead Ss Measured Section - Ivishak River



- Vertical-overturned beds
- Alternating 30-50 m cycles
  - amalgamated ss
  - thin-bedded ss-slts

Gilead Amalgamated Sandstone Facies

- **High-density Sediment Gravity Flows – Hyperpycnites(?)**

stratigraphic up

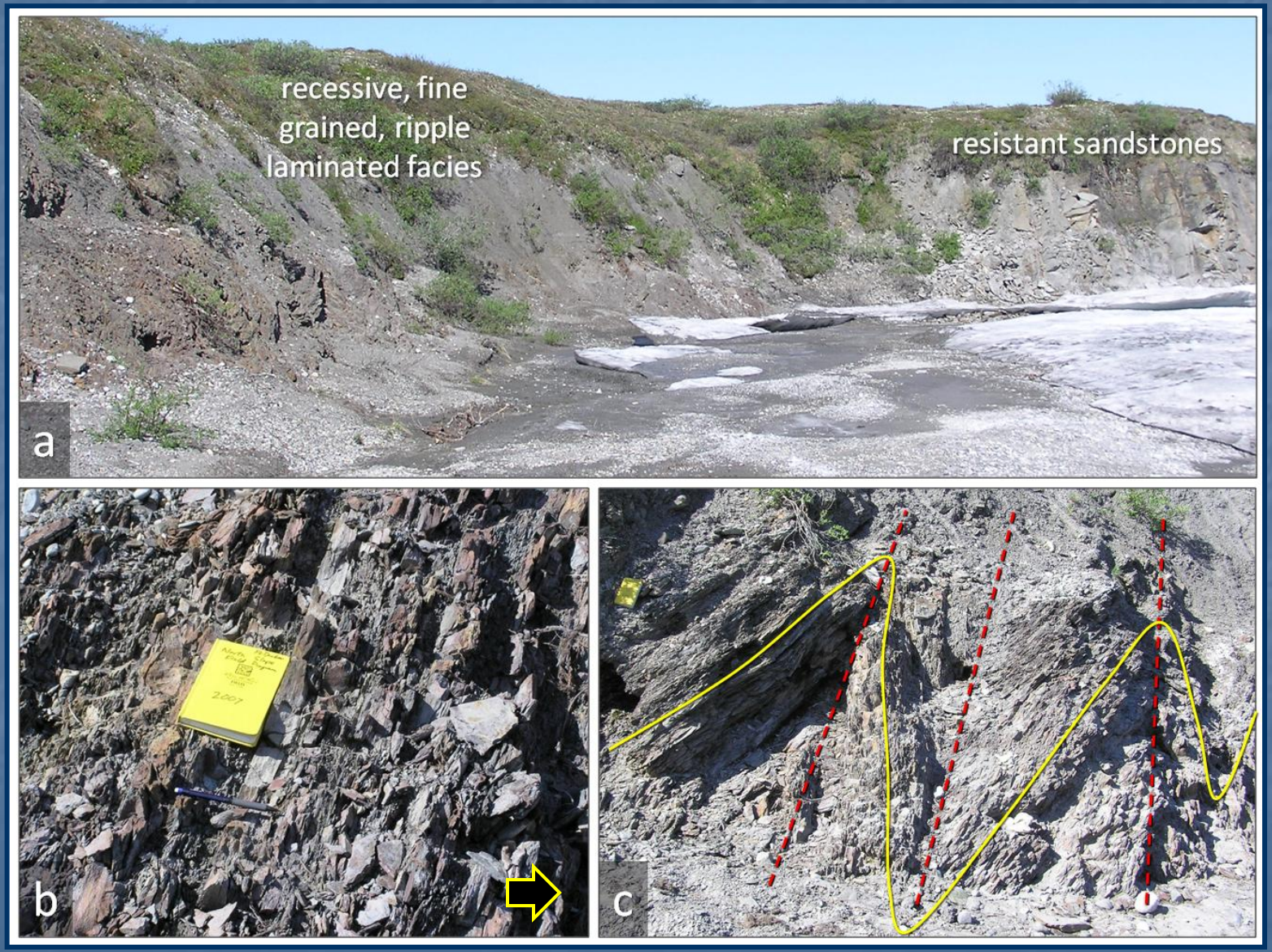
Flood event bed? 3.5 m thick (Tab, woody Tc rippled cap)

Gilead Amalgamated Sandstone Facies

- **High-density Sediment Gravity Flows – Hyperpycnites(?)**

Gilead Fine-Grained Facies

- Thin-bedded, current-rippled low-density turbidites

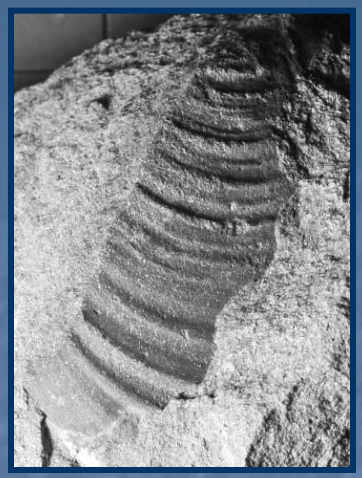


New Megafossil Age Control – Gilead

(William Elder, consultant)

Inoceramus sp.cf. *I. altifluminis* McLearn ?

upper lower to middle Albian



Mytiloides mytiloides (Mantell)?

lower Turonian – Seabee eq.

Inoceramus dunveganensis McLearn ?

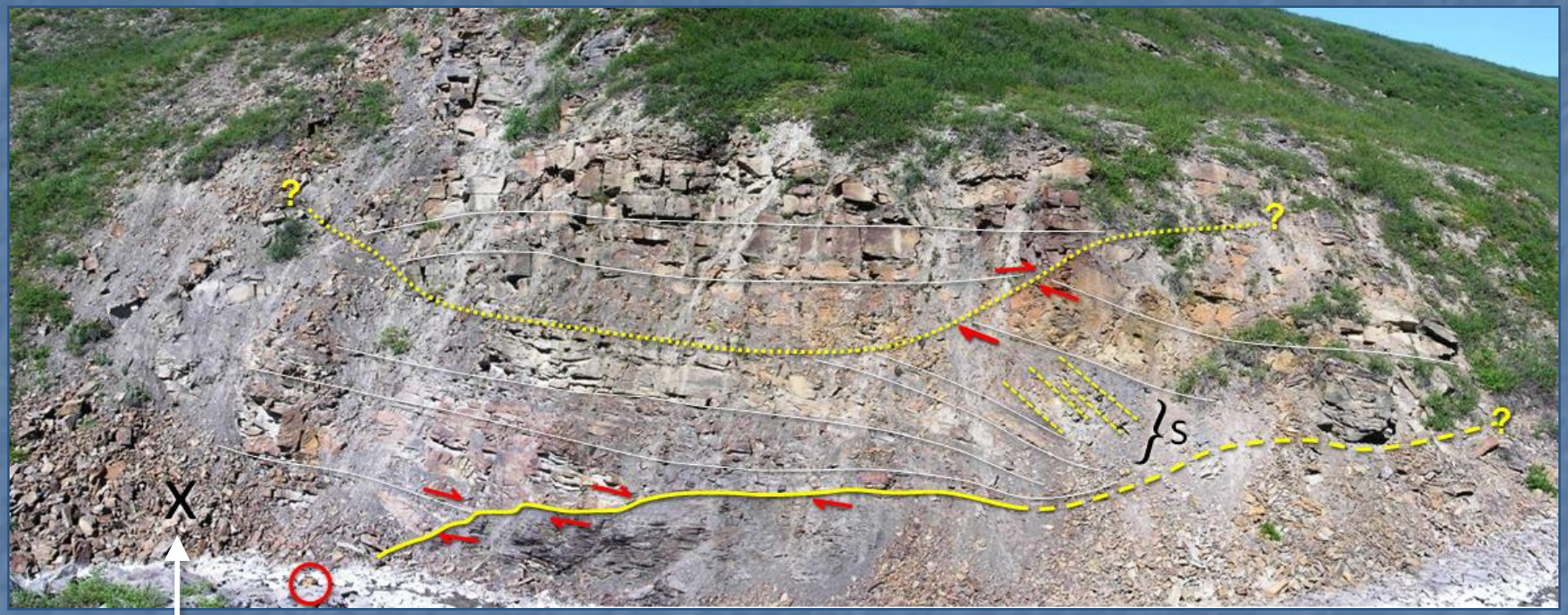
latest Albian to middle Cenomanian

Paragastroplites? sp. aff. *P. lairdense* Whiteaves

early late Albian or late middle Albian

Submarine Channels – Gilead Syncline

- amalgamated ss fill, incised into fine grained facies



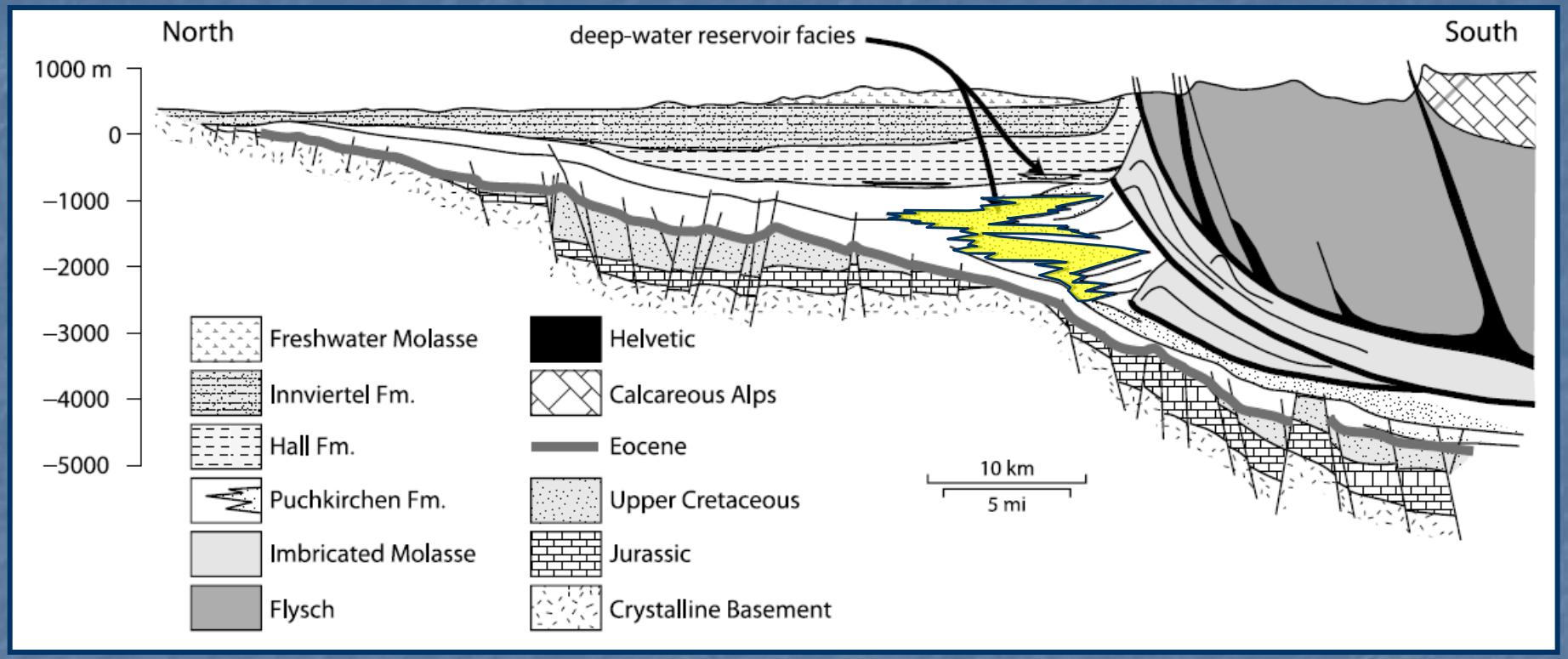
Gastroplitid ammonite
middle to late Albian

Local Wave Influence – SGF deposits

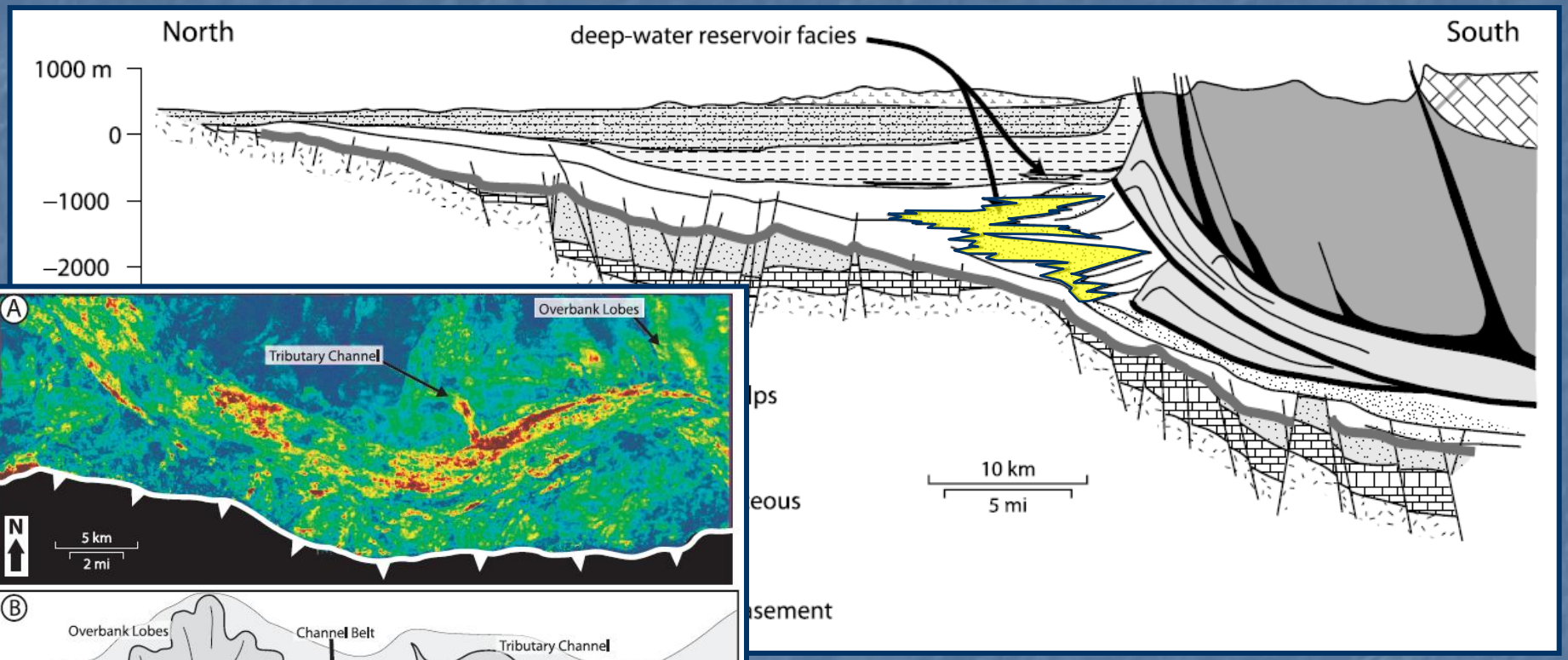
- most apparent in upper part of Gilead (shoaling?)

Axial channel belt: Oligocene Puchkirchen Fm

Molasse foreland basin, Austria



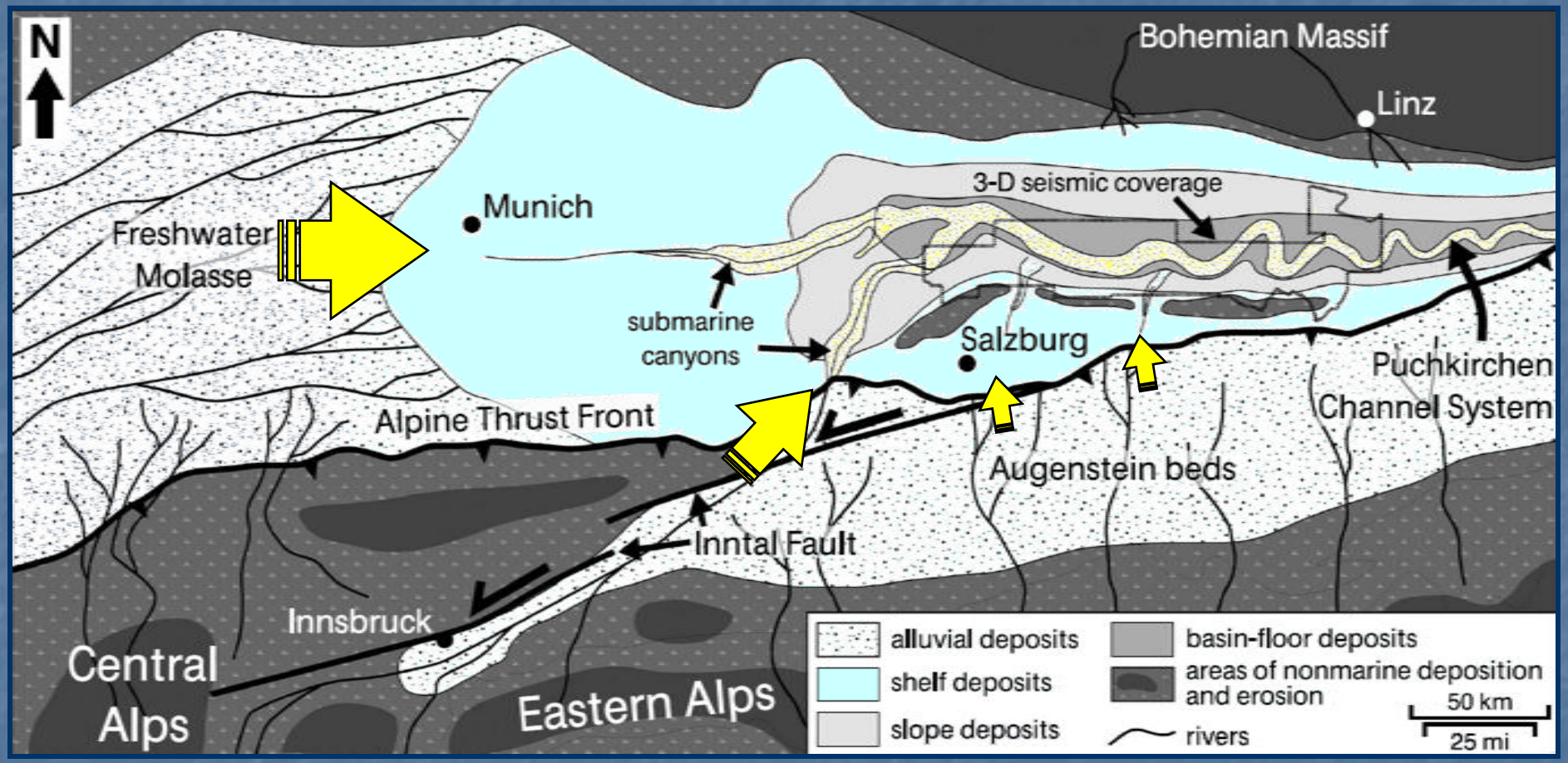
Axial channel belt: Oligocene Puchkirchen Fm
Molasse foreland basin, Austria



Low-sinuosity deepwater channel belt:

- 3-5 km wide, 100 km long (basin axis)
- Coarser channel ss & finer overbank
- Lateral migration → interbedded cycles
- Ponded slope fans south of basin axis

Axial channel belt: Oligocene Puchkirchen Fm
Molasse foreland basin, Austria



Close association of westerly-sourced axial deepwater deposits and southerly-sourced orogen-attached shelf to nonmarine deposits

Juxtaposition with Upper Cretaceous?

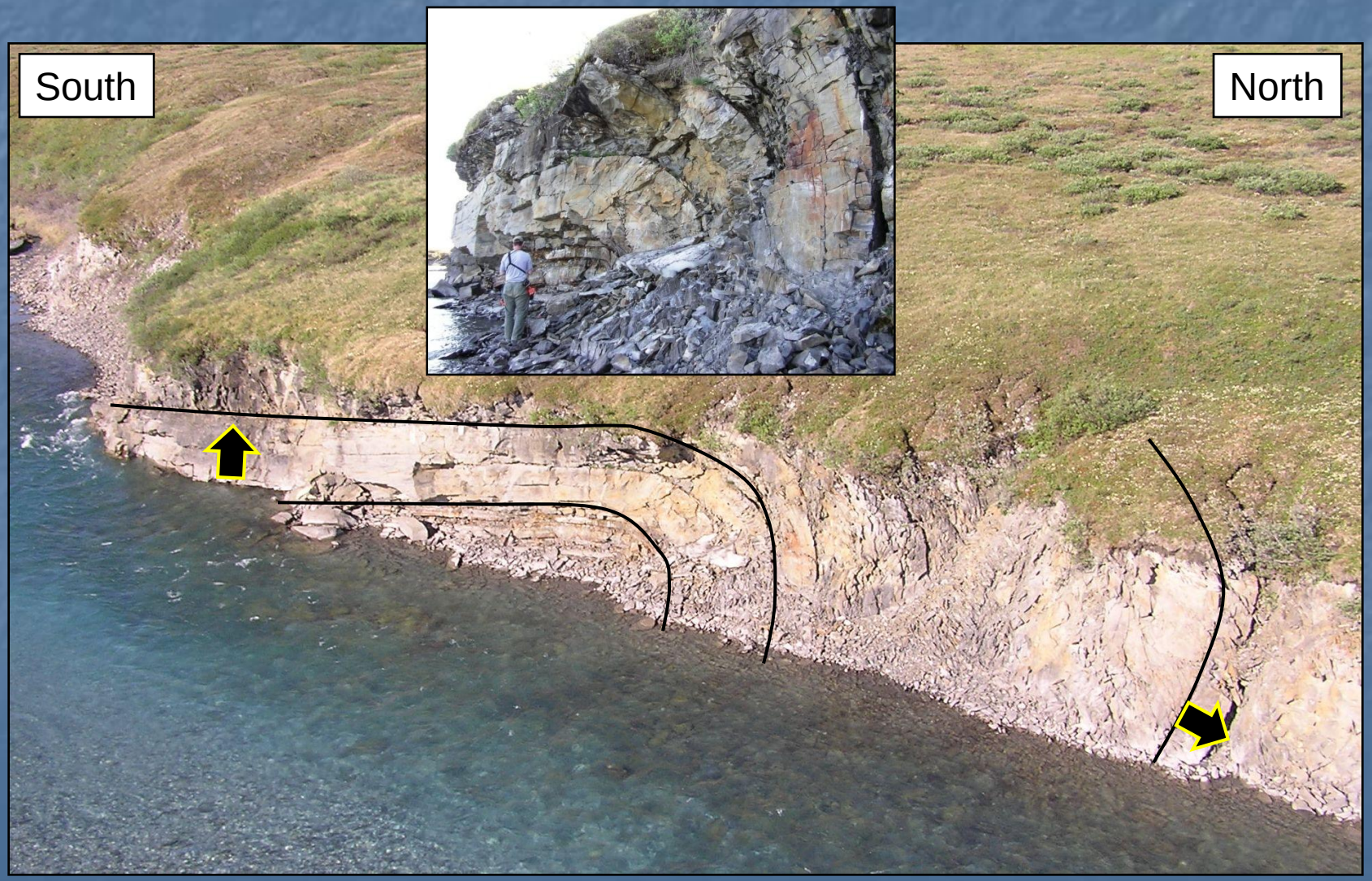
- **Fault or angular unconformity?**

Upright bentonitic-sideritic mudstone (Seabee, Canning?)

Overturned fine-grained, ripple- laminated Gilead facies

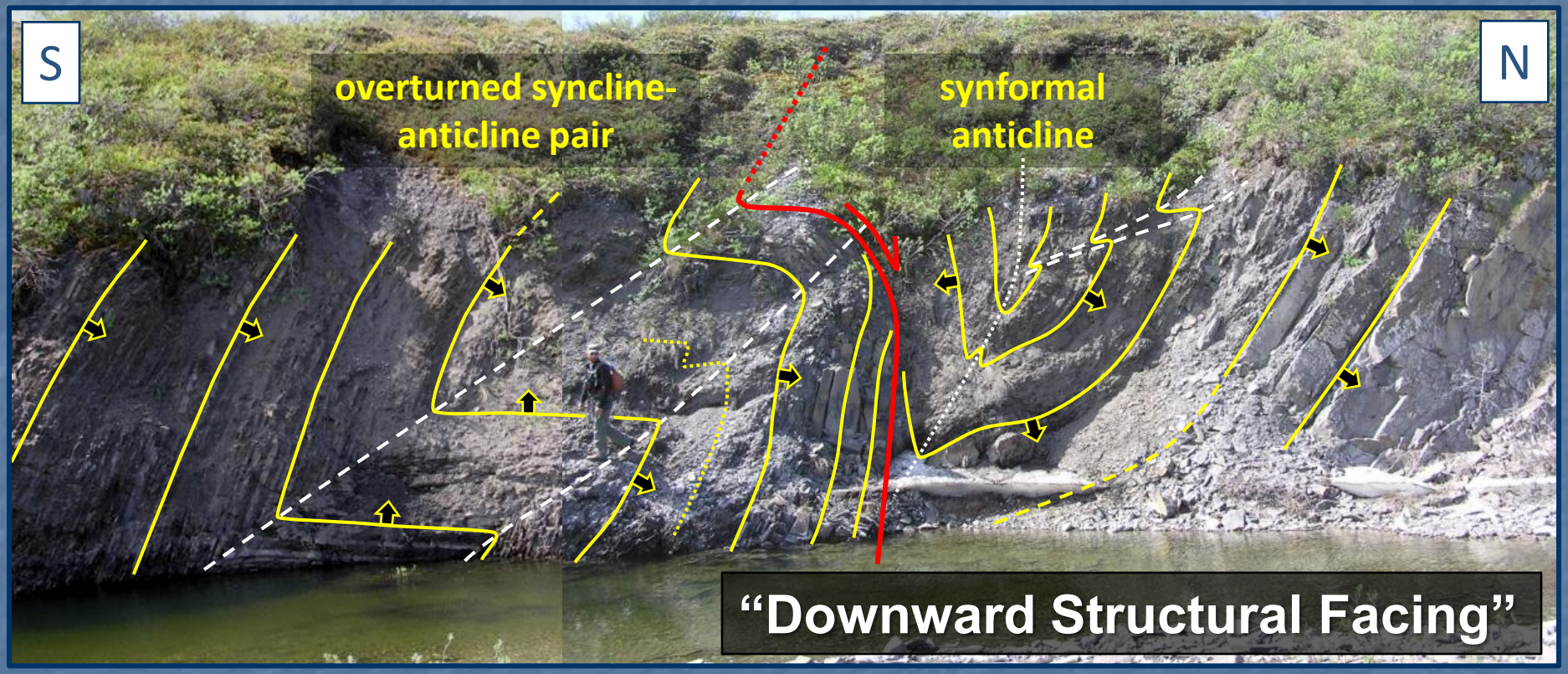
Structural Style – Ivishak River

- "Well-behaved Rocks" – Concentric N-vergent fold



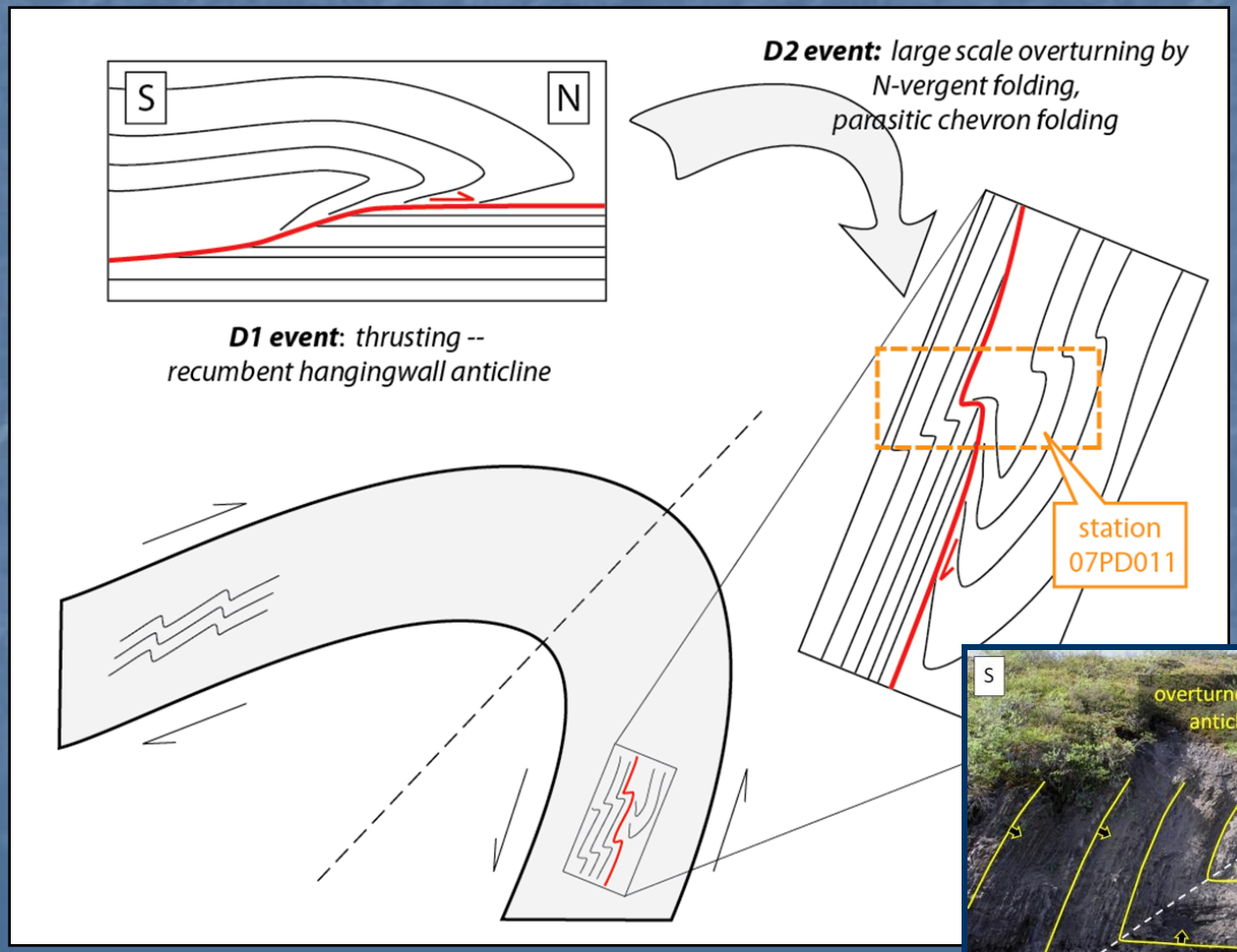
Complex Deformation – Ivishak River

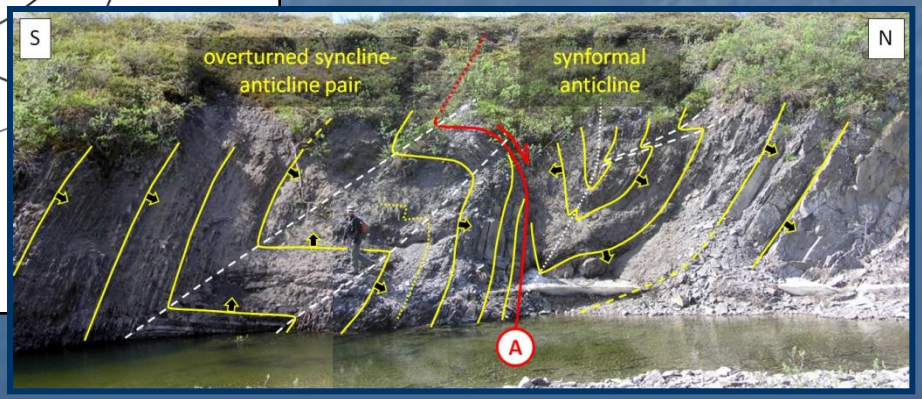
- "Bad Rocks" – severe punishment



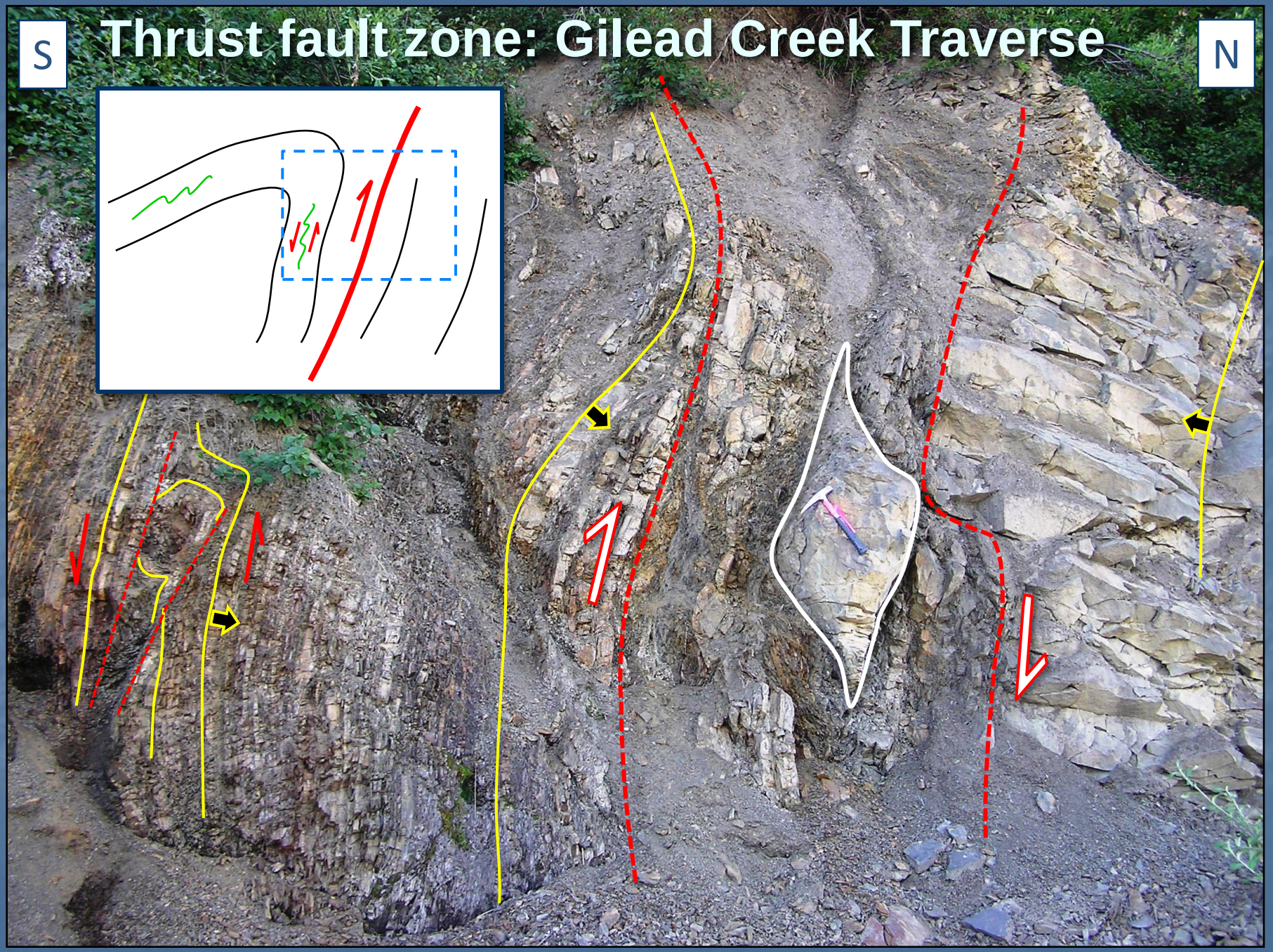
Deformation Hypothesis – Ivishak River

Downward-facing folds: 2 stages of deformation



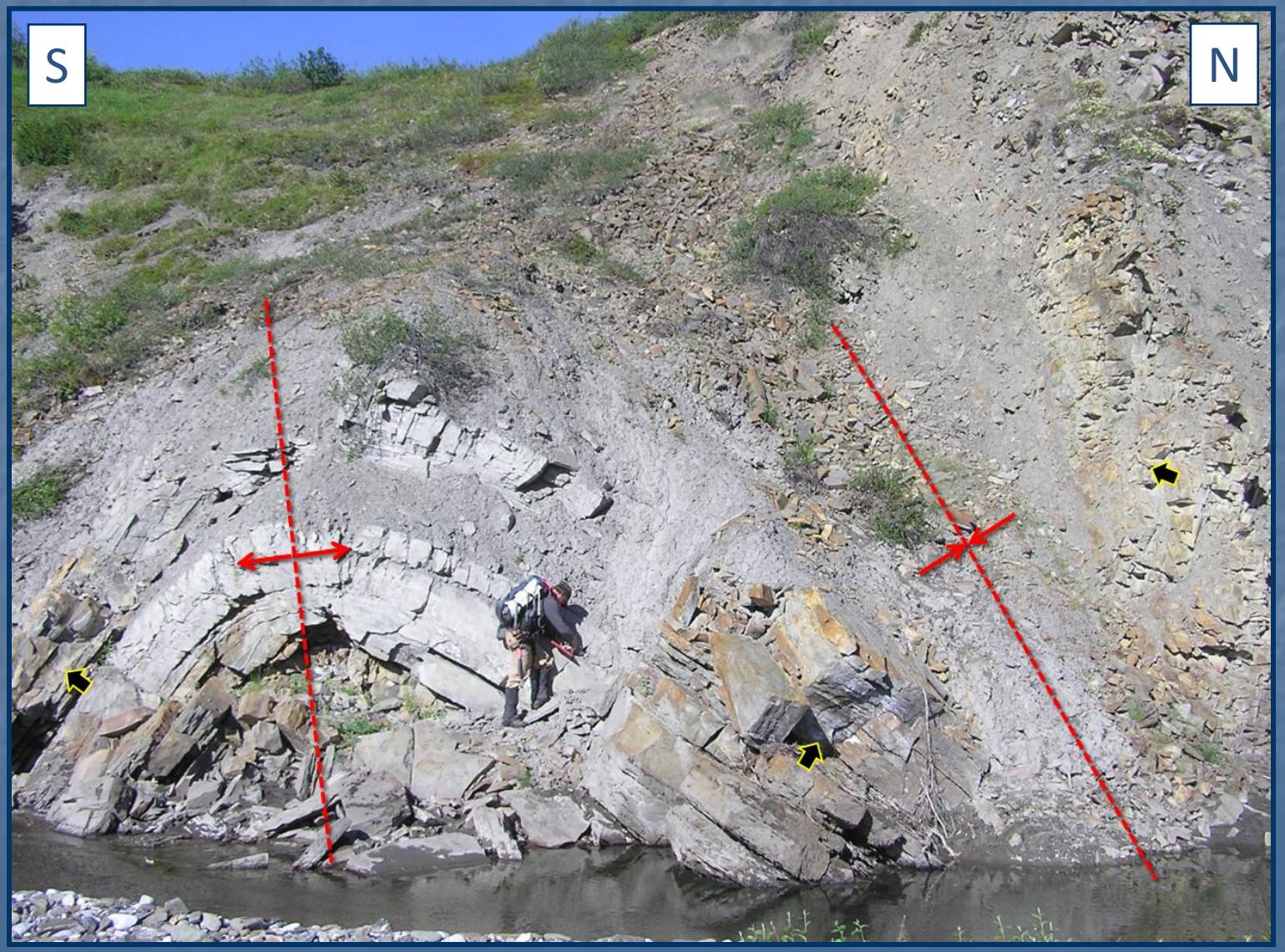


Thrust fault zone: Gilead Creek Traverse



Upper Gilead/Seabee eq? - Gilead Creek

- Reversal of fold asymmetry (south –vergence)



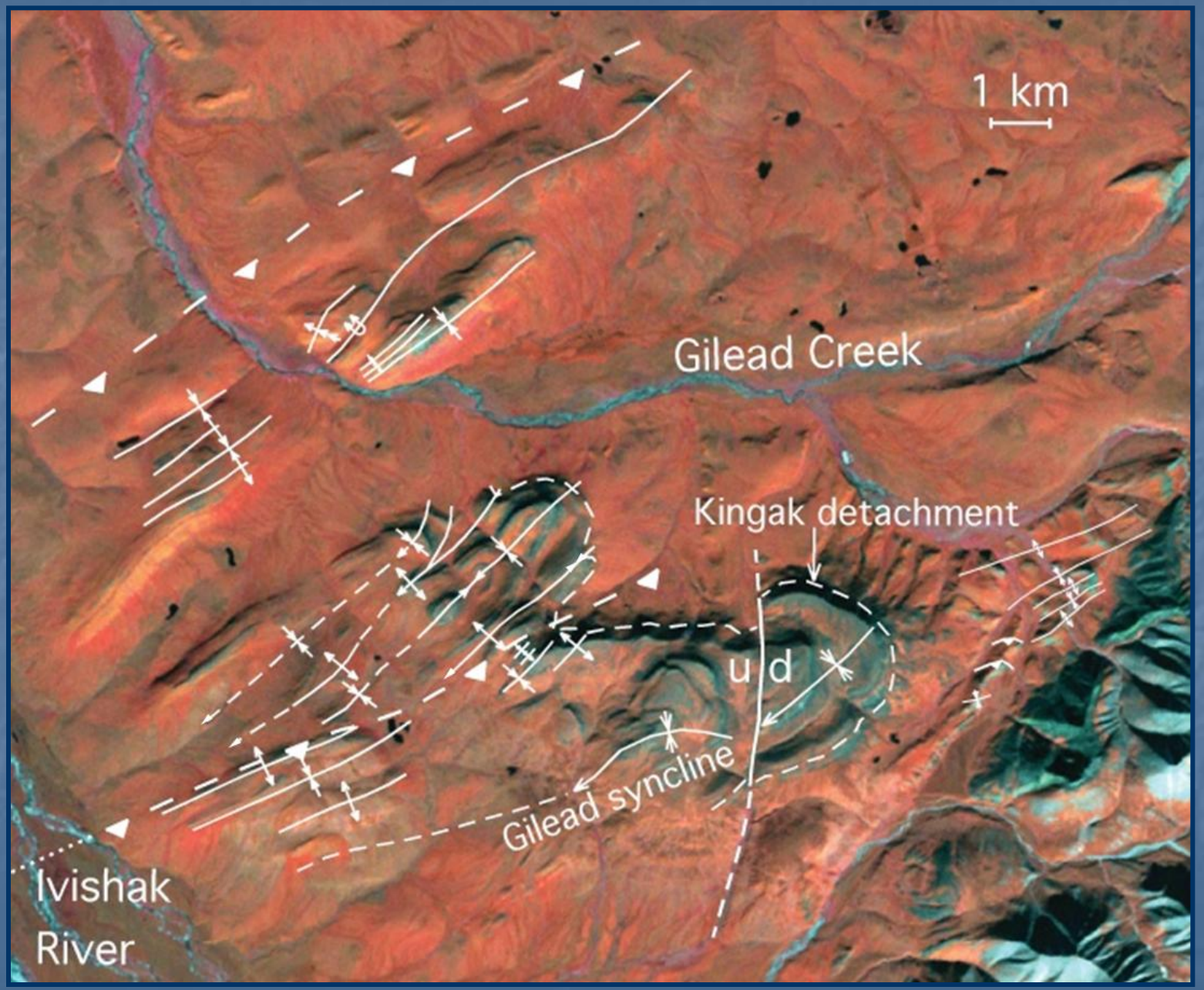
Is the Gilead succession allochthonous?

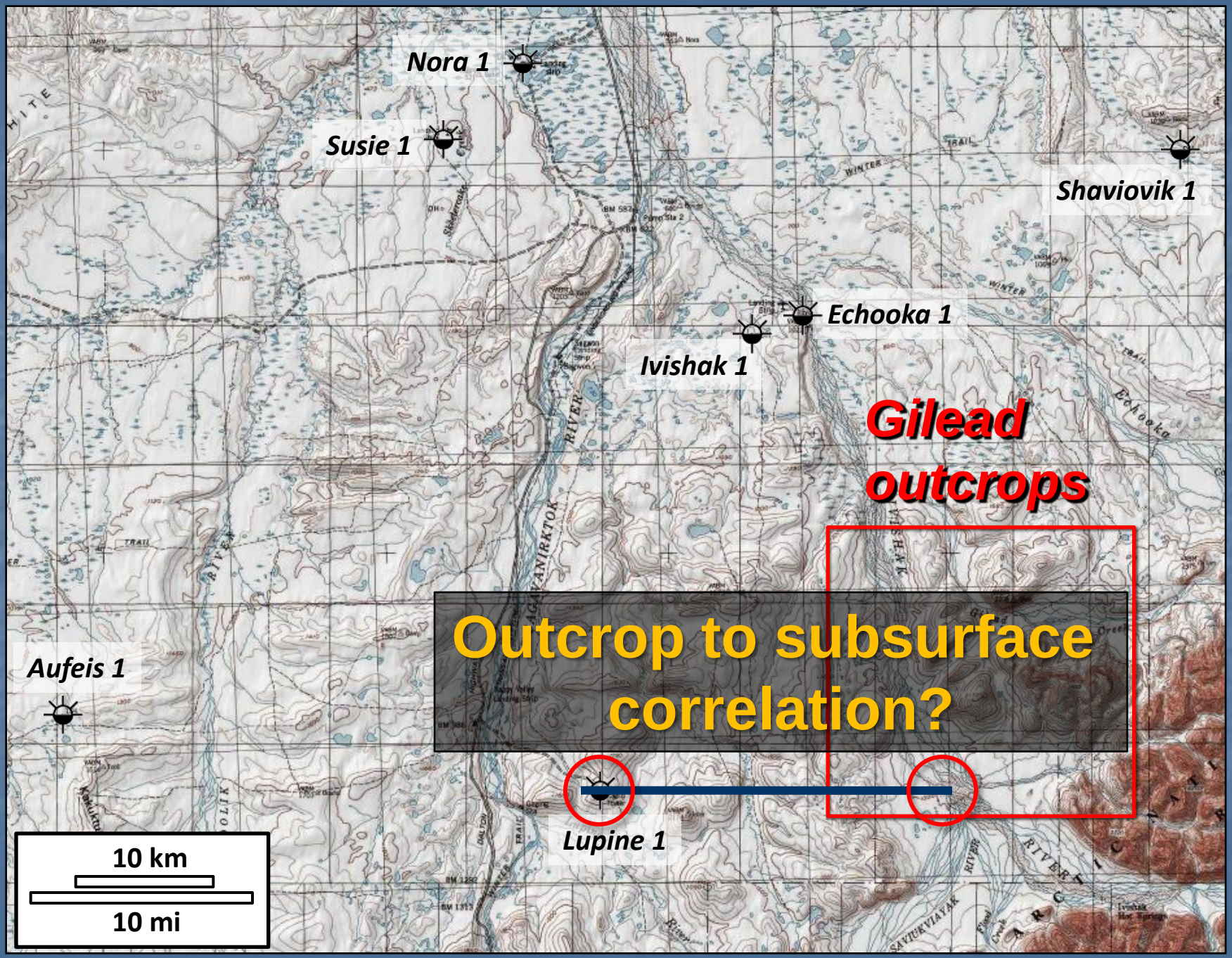
- Gilead sandstone is absent from exposures <20 km NE on Echooka River (Kingak, Kemik, pebble shale/GRZ, Canning)

- Basal contact is covered, but has been mapped as a thrust fault at Gilead syncline. Underlying Kingak Fm (Miluveach-eq) is more intensely deformed than the Gilead sandstone → mechanical detachment of some sort.

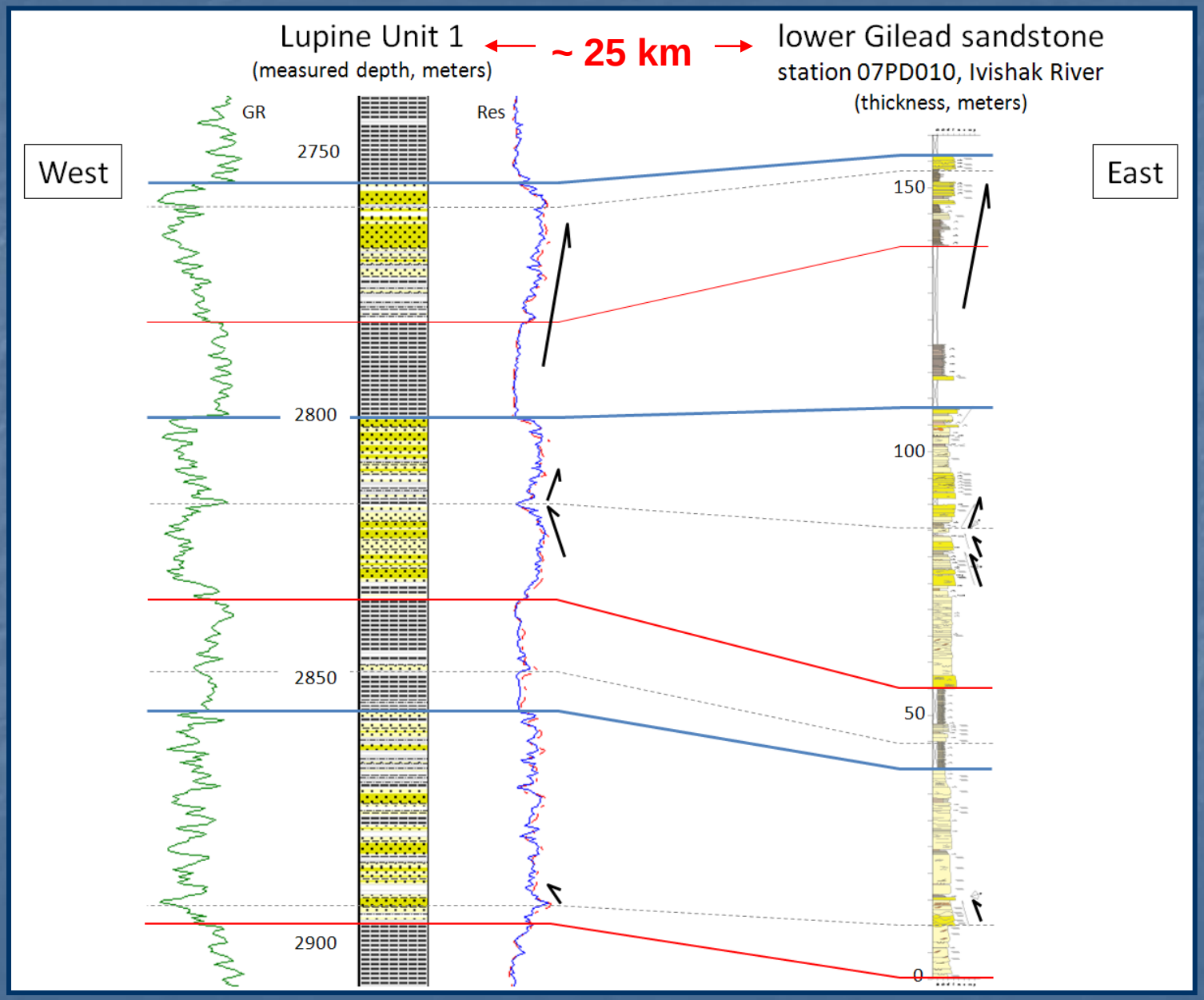
- The relationship is younger-on-older, with possible omission of section, not repetition (LCU, Kemik, pebble shale/GRZ, etc. appear to be absent here). Could contact be a major low-angle normal fault or gravity-glide surface?

Preliminary Re-mapping, Gilead Syncline Area



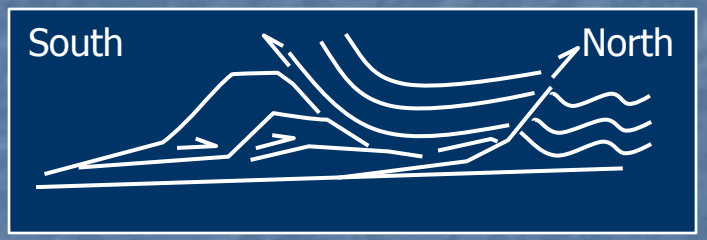

Nora 1
Susie 1
Shaviovik 1
Echooka 1
Ivishak 1
Gilead outcrops
Outcrop to subsurface correlation?
Aufeis 1
Lupine 1
10 km
10 mi

Lower Gilead ss – Lupine 1 well correlation?



Gilead succession may be ~ in-situ:

- Detachment surface at Gilead syncline may be a passive roof backthrust, Kingak & older units imbricated below

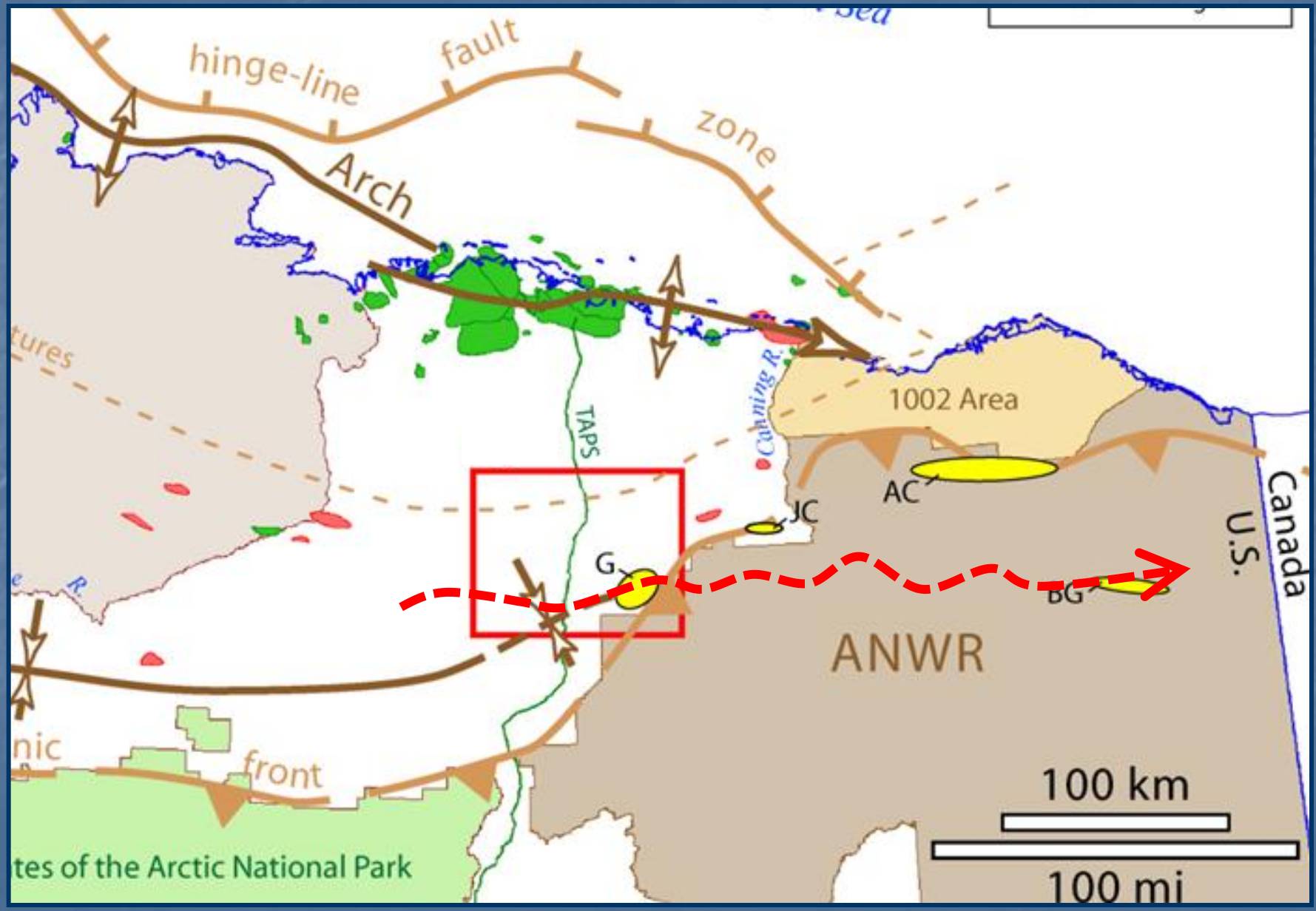


- Gilead sandstone may correlate with alternating sandstone-mudstone lower Brookian strata in the Lupine 1 well 25 km due west

- Genetic link to Bathtub Graywacke, Arctic Creek unit, and Juniper Creek unit? (long, narrow, basin-axis deepwater depositional system)

- Highly continuous, overpressured sand-rich basin-axis
  → deep gas prospectivity?

Gilead succession may be ~ in-situ:



Results to date
PIR 2008-1F

To be continued:

- Petrography
- Chemostrat
- Biostrat (micro & mega)
- Thermochronology

STRATIGRAPHIC AND STRUCTURAL INVESTIGATIONS IN THE IVISHAK RIVER AND GILEAD CREEK AREAS: PROGRESS DURING 2007

by
P.L. Decker[1], M.A. Wartes[2], W.K. Wallace[3], D.W. Houseknecht[4], C.J. Schenk[5], R.J. Gillis[2], and J. Mongrain[3]

Abstract

Contractional deformation of foreland basin deposits adjacent to the northeast–southwest-trending mountain front in the east-central Brooks Range foothills exposes rock units of Albian to Late Cretaceous age that are largely concealed in the subsurface to the west and removed by erosion to the east. The informally named Gilead sandstone and overlying units in this area provide valuable insights into depositional systems active during the early and middle phases of foreland basin evolution, as well as an opportunity to study their responses to subsequent Brookian deformation. Systematic traverses of the Ivishak River, Gilead syncline, and Gilead Creek yield ubiquitous evidence of sediment gravity flow depositional processes in both the highly amalgamated sandstones and the intervening, finer-grained and thinner-bedded intervals throughout the Gilead sandstone, Seabee-equivalent strata, and the overlying Canning Formation. The amalgamated sandstone facies association of the Gilead succession contains many characteristics of hyperpycnal flow deposits, and submarine channels are locally preserved. Much of the unit may represent east- or northeast-flowing axial foredeep channel belt deposits. Sediment gravity flow sandstones in the upper parts of the Gilead unit that contain possible wave-influenced sedimentary structures may have been deposited south of the foredeep in shallower orogenic wedge-top, upper slope, or ramp settings. The Gilead sandstone has previously been interpreted to belong to a far-traveled allochthon, but we have found no compelling structural evidence to support this interpretation. Instead, observations appear consistent with lower Brookian strata at Gilead syncline forming the passive roof of a triangle zone duplex containing structurally thickened Valanginian and older strata. The Gilead sandstone itself is more strongly deformed on strike to the west at the Ivishak River. Transverse tear and rotational faults may account for the along-strike compartmentalization of deformation. These preliminary interpretations require further scrutiny and the incorporation of pending analytical results from samples collected during these investigations.

INTRODUCTION

Reconnaissance during the 2007 field season addressed stratigraphic and structural uncertainties in the Ivishak River–Gilead Creek area (figs. 1–3) in preparation for detailed geologic mapping in this part of the Foothills belt during 2008 and subsequent years. These drainages are located on the northeast–southwest-trending edge of the northeastern Brooks Range salient where rocks of the lower and middle Brookian sequence that are restricted to the subsurface in most of the Foothills have been brought to the surface. This presents a unique opportunity to study the evolution of the foreland basin, and provides direct insight into the Foothills petroleum system in the adjacent subsurface.

An inherent challenge to understanding the Brookian foreland basin sequence is that the nomenclature, organization, thickness, depositional environments, and lithostratigraphy of the succession in any given area may be very different than the stratigraphic equivalents elsewhere in the basin (for example, Molenaar and others, 1986; Decker, 2007). The Ivishak River–Gilead Creek outcrop belt presents a conundrum analogous to trying to solve a system of equations with too many variables: the Brookian sequence differs dramatically from other areas, but because of obvious structural complications, the original stratigraphic succession has never been fully reconstructed. Conversely, the complete structural picture remains elusive, and thus difficult to filter out, because the original stratigraphy is not adequately understood.

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