GEOLOGICAL SURVEY OF CANADA
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Basement Controlled Mineralization, Intrusions and Facies, Southeastern British Columbia; "Two for One Exploration Targets"

M.E. McMechan

2010

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MINERALIZATION, INTRUSIONS AND SEDIMENTARY FACIES CONTROLLED BY BASEMENT STRUCTURES IN SOUTHEASTERN BRITISH COLUMBIA; “TWO FOR ONE” EXPLORATION TARGETS

Margot McMechan

Outline[1]

1. Important transverse basement structures occur under Eastern Cordillera.

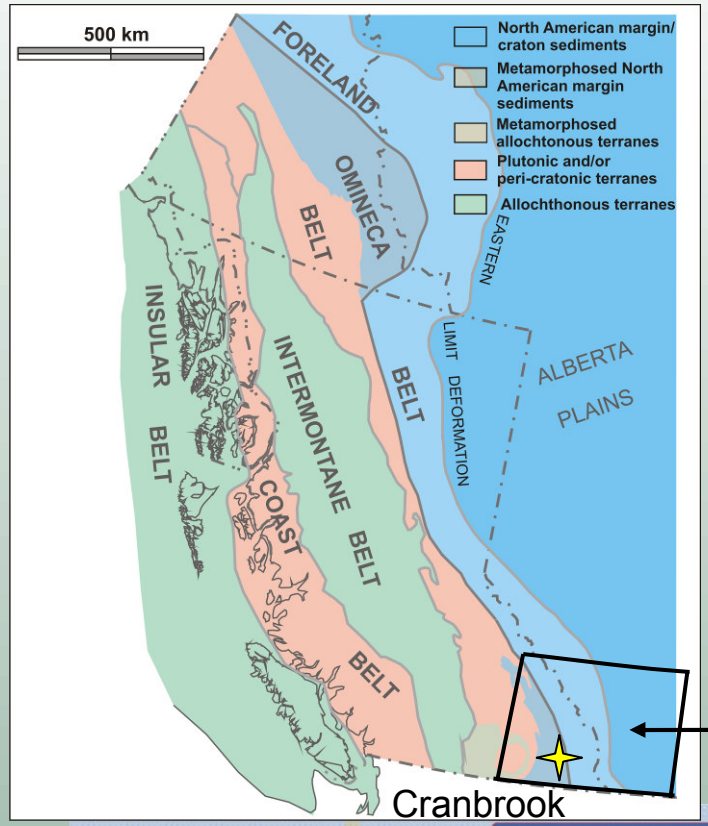
2. Develop a tool kit of characteristics to recognize important basement structures using Vulcan Low structure as the “type” example.

3. Use these characteristics to recognize a new more northern basement-fault controlled zone no longer above its roots.

4. Show buried basement structure helped localize Tertiary mineralization.

5. Conclusions – basement structures “Two for One” exploration targets.

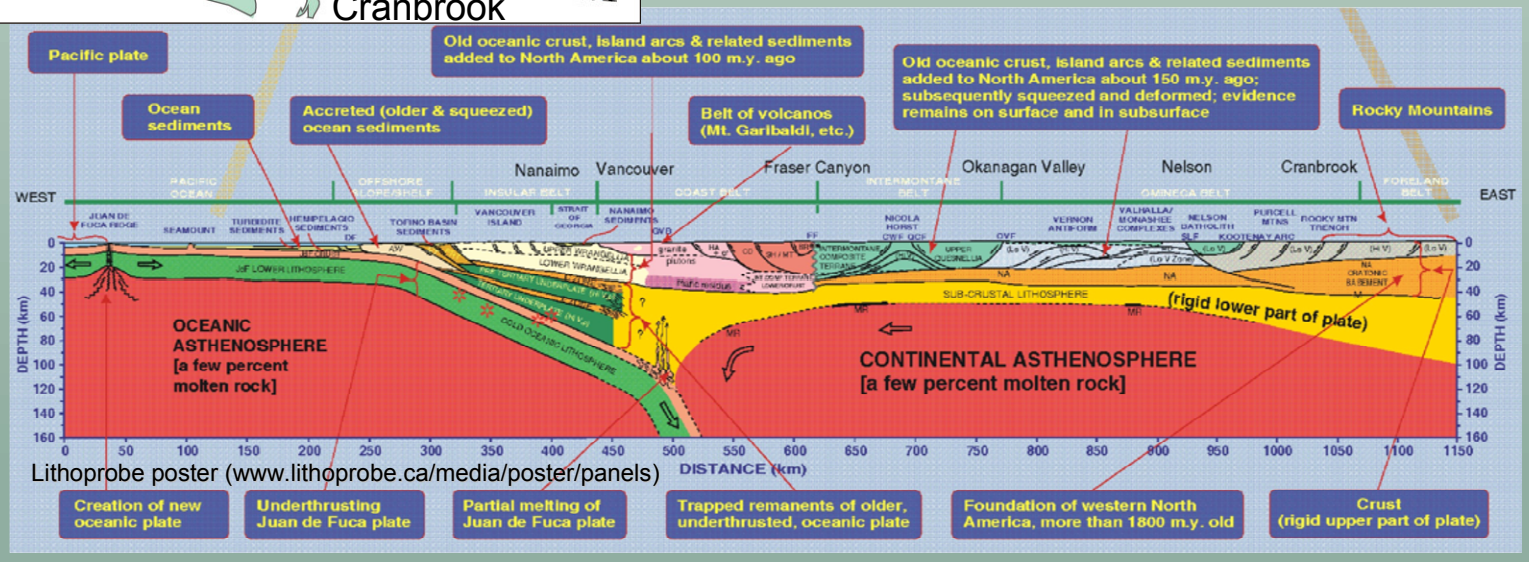
6. New exploration targets provided by basement structures.



North American cratonic basement underlies southeastern Canadian Cordillera

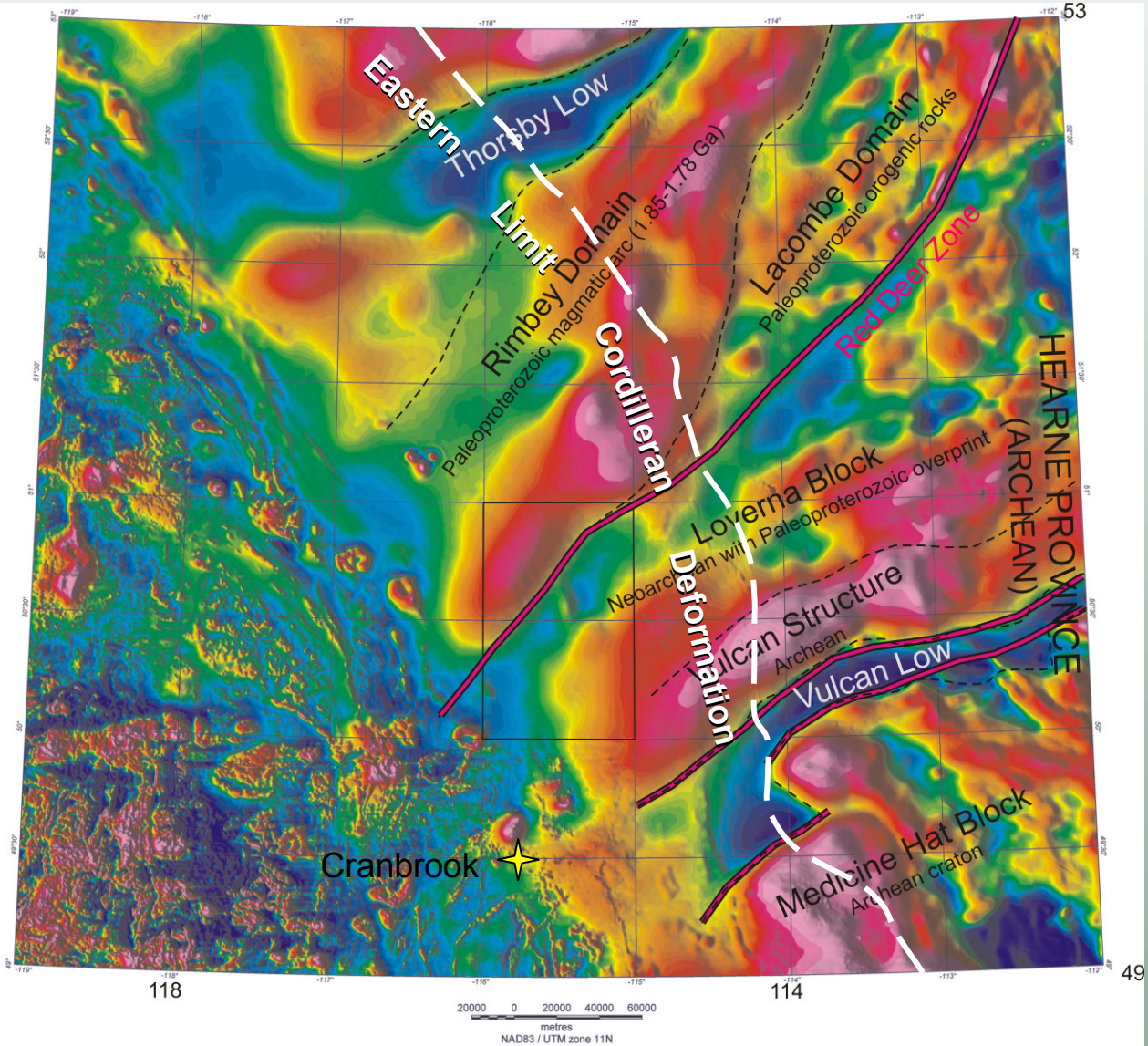
From deep seismic and crustal refraction studies know cratonic basement extends as far west as the Fraser Canyon

Aeromag map



Lithoprobe poster (www.lithoprobe.ca/media/poster/panels)

Shaded Total Magnetic Field



Domain boundaries after Hope and Eaton (2002)

(Image derived from Canadian Aeromagnetic Database)

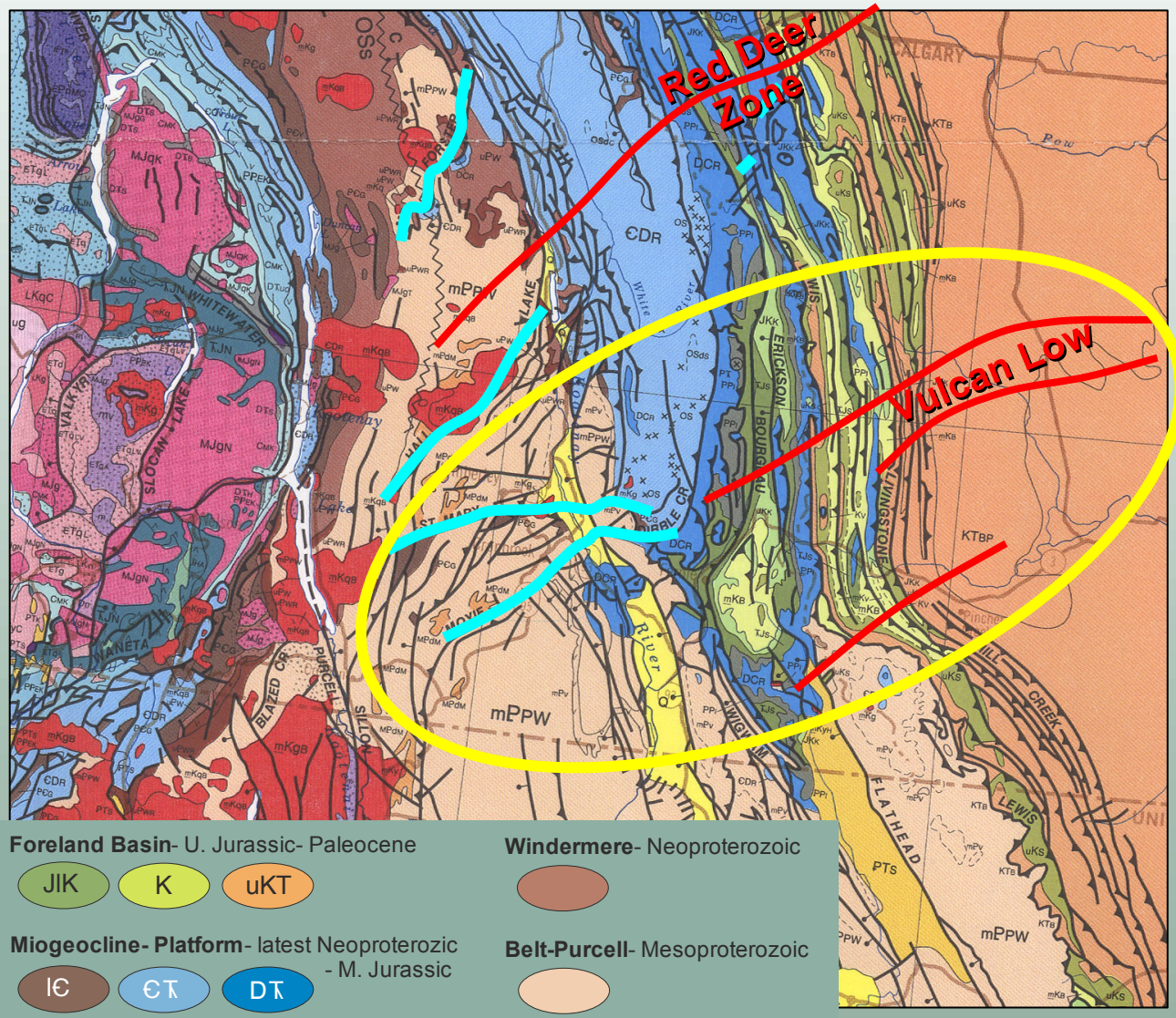
Basement structure outlined by deep geophysics, well intersections and aeromagnetic anomalies

Fundamental boundaries in North American cratonic basement:

- formed during growth of craton

- oriented transverse to Cordilleran structural trend

Major Transverse Faults in Adjacent Cordillera



Segments of right-hand reverse faults in Purcell Mountains

Follow pre-existing structures that affected Proterozoic/ Paleozoic sedimentation

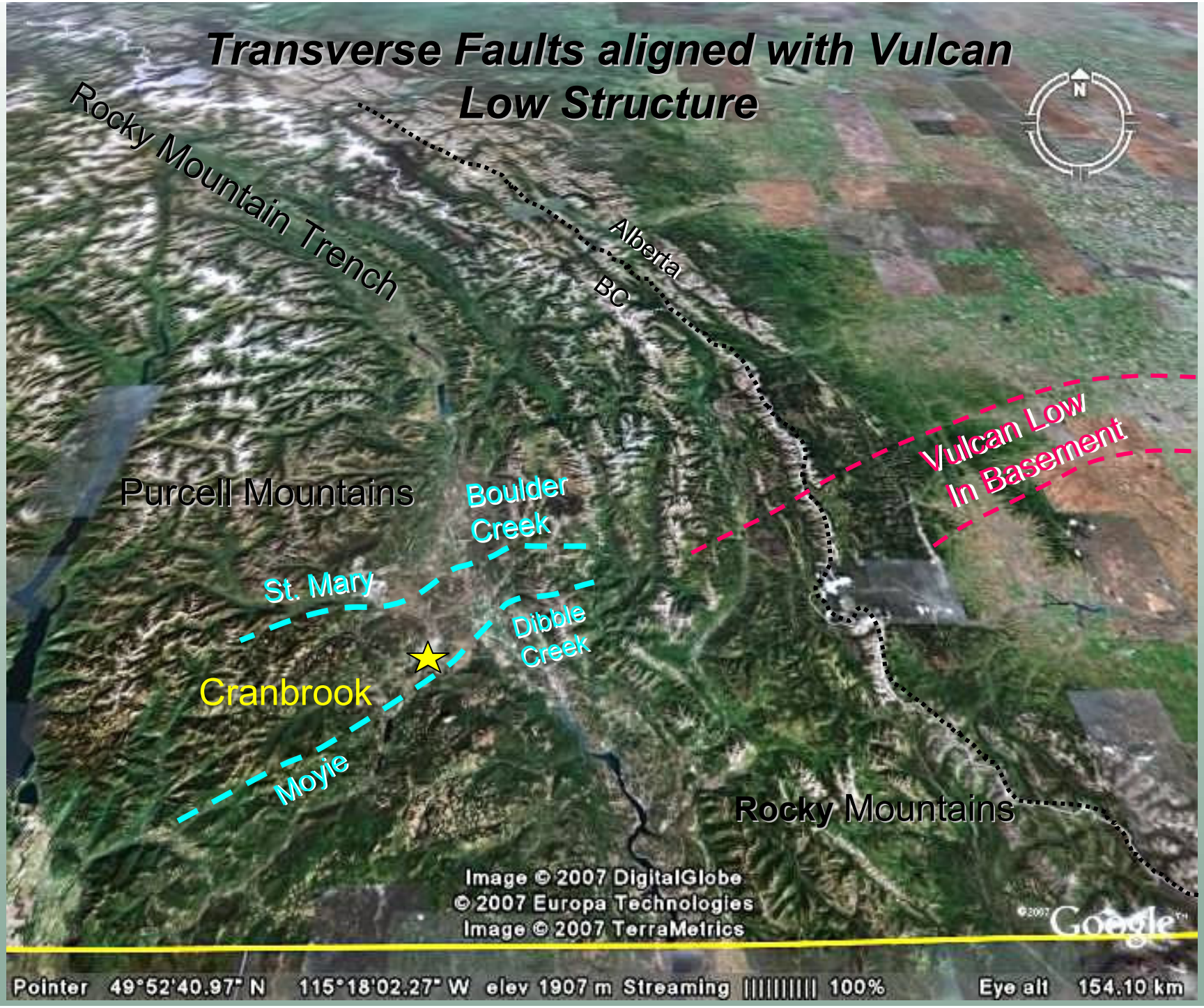
Southern transverse faults aligned with Vulcan Low

Transverse fault

Basement boundary

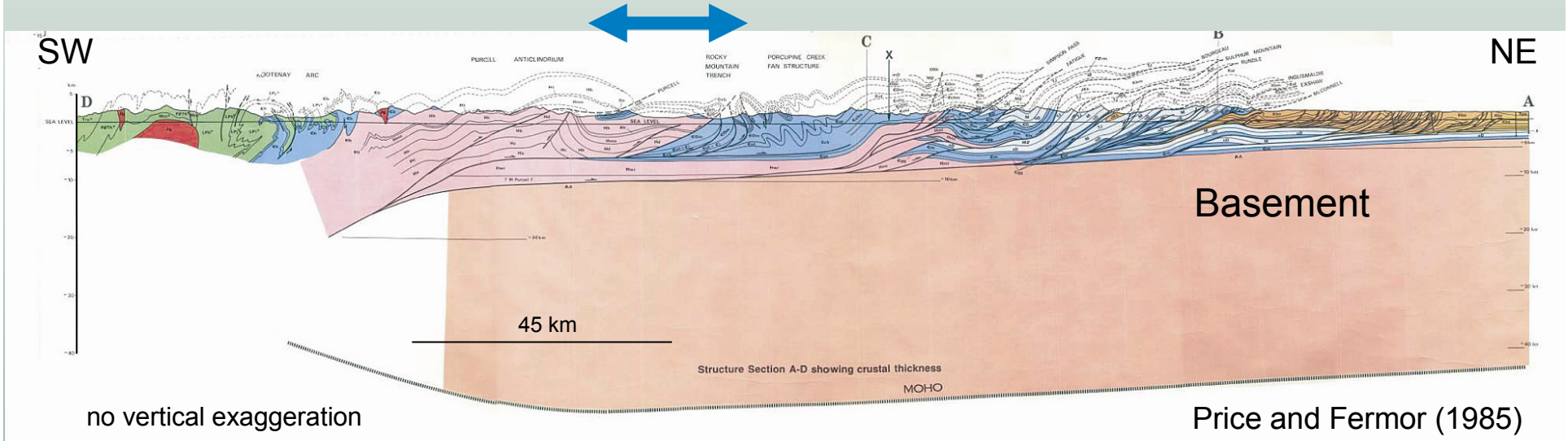
Base map for this and several following figures is: The Tectonic Assemblage Map of the Canadian Cordillera (Wheeler and McFeely, 1991).

Transverse Faults aligned with Vulcan Low Structure



Geological Cross Section, Fold and Thrust Belt

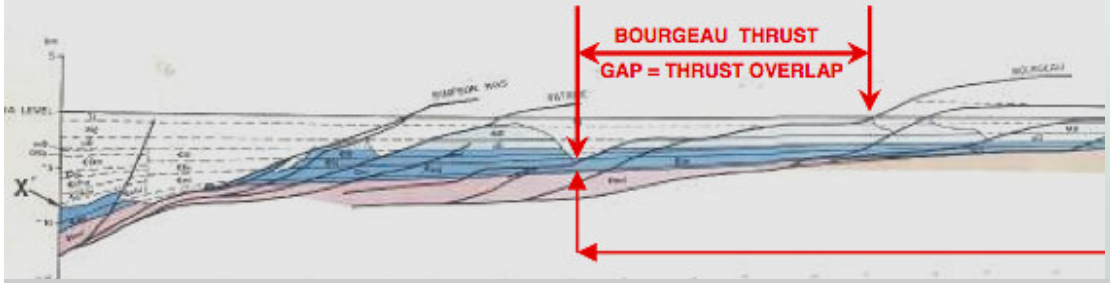
Structural position
exposed transverse
fault segments



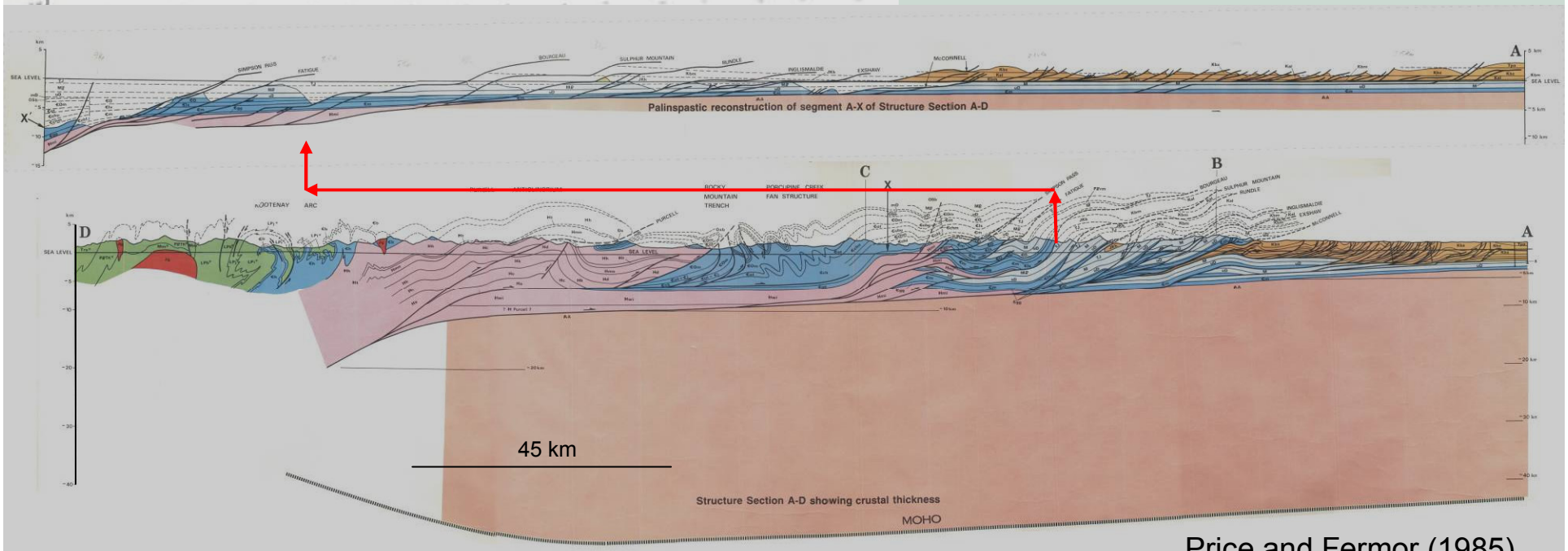
Exposed transverse faults are in fold and thrust belt formed above a basal detachment and crystalline basement

Exposed transverse faults have moved northeastward with fold and thrust belt and are detached from original position of roots in basement

Palinspastic Restoration -Bourgeau Thrust



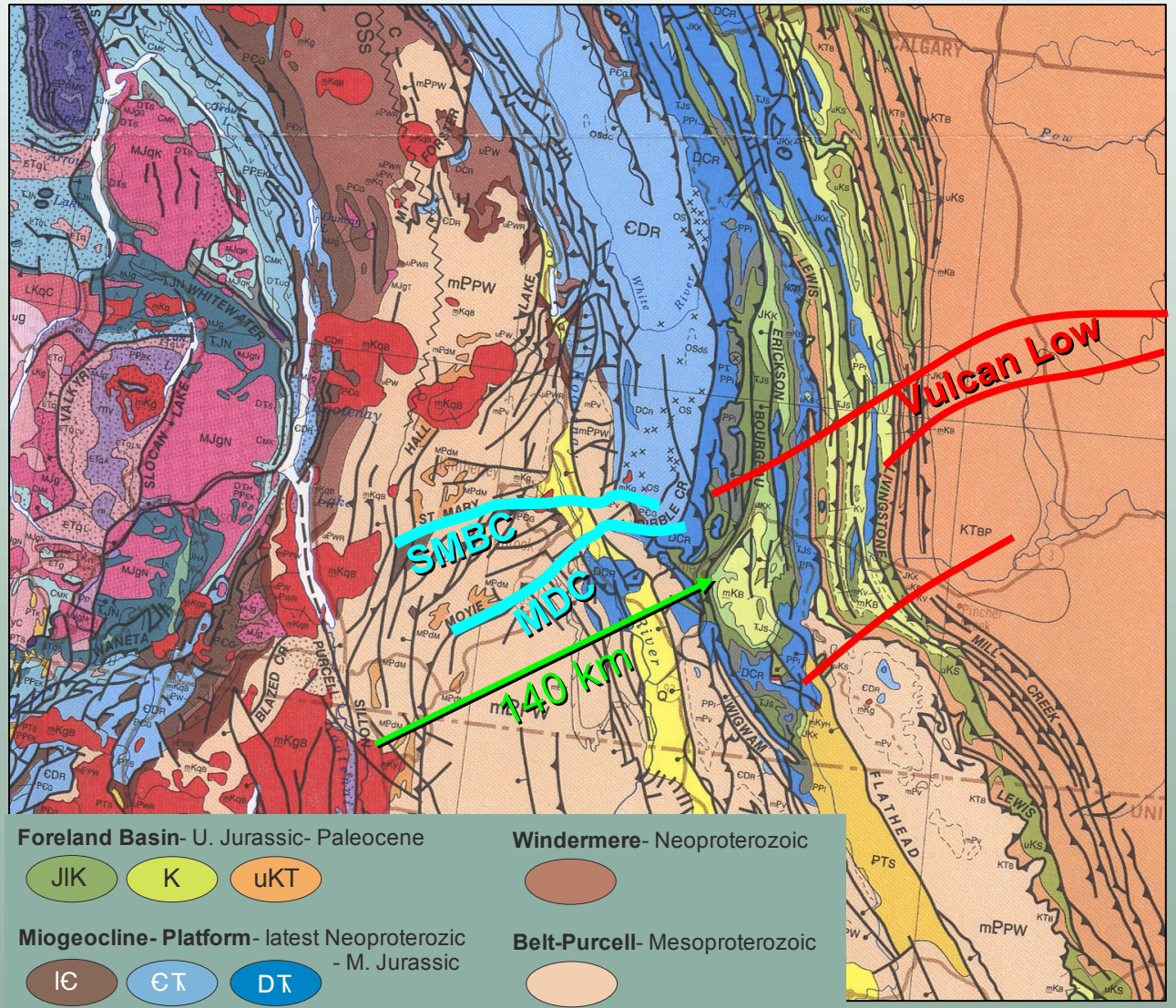
Palinspastic restoration involves restoring deformed rocks back to their original thickness and length



Price and Fermor (1985)

Arrows on lower diagram indicate present day and restored position of the leading edge (surface trace) of the Bourgeau Thrust. The long arrow gives the total amount that strata at the leading edge of the Bourgeau have been displaced northeastward by shortening along the Bourgeau Thrust and all the faults and folds to its northeast. The gap in the restoration from the rocks in the immediate hangingwall at the leading edge (west arrow upper diagram) to the rocks in the immediate footwall at the leading edge (east arrow upper diagram) represents the amount of displacement on the Bourgeau Thrust fault itself. This shortening occurred in the Upper Cretaceous and Tertiary.

Transport direction of thrust faults in Rockies parallel to Vulcan Low basement structure

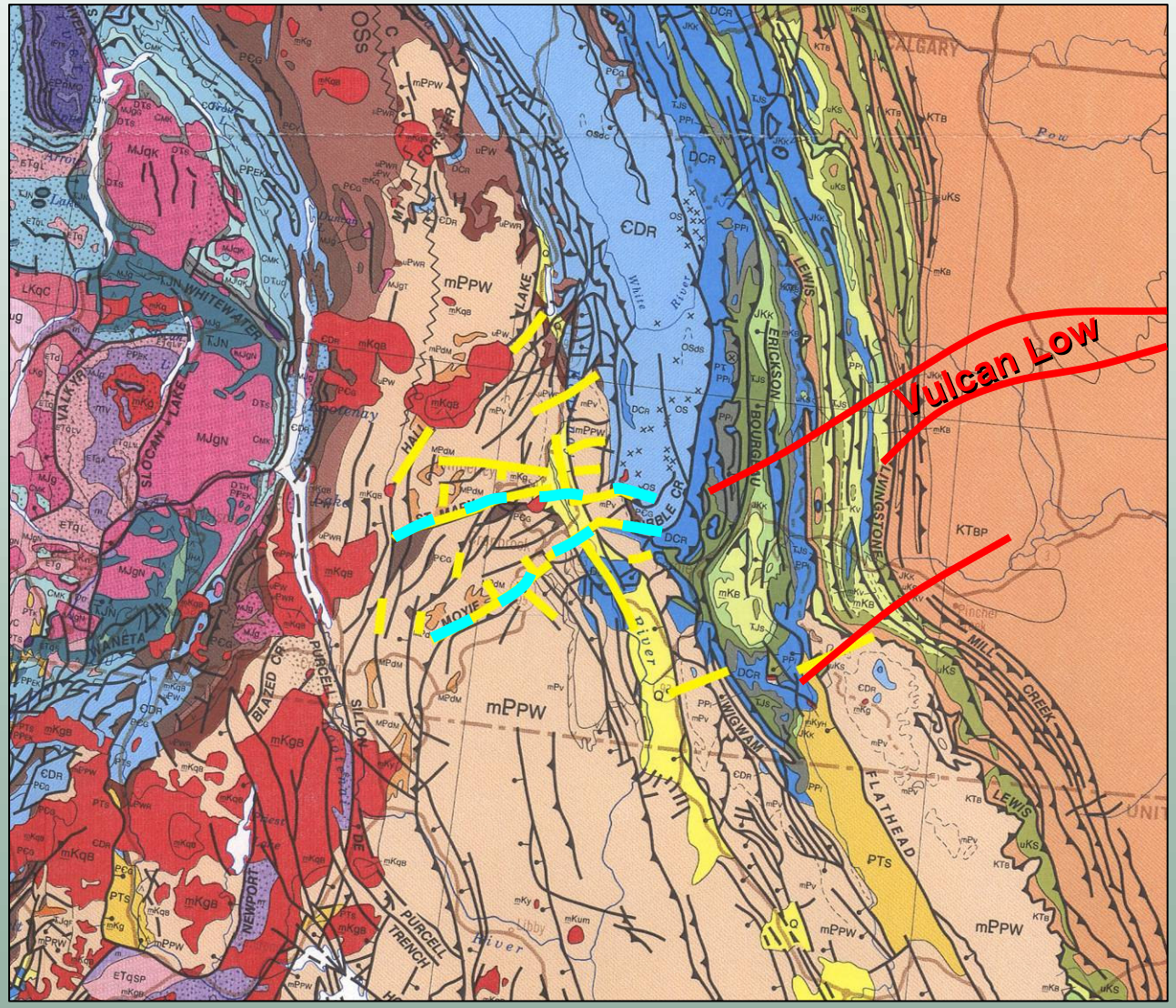


Large changes in thickness and facies occurred across antecendents of St. Mary- Boulder Creek (SMBC) and Moyie – Dibble Creek (MDC) faults [2]

Price and Lis (1975) first linked these structures to the Vulcan Low basement boundaries

Green arrow indicates amount and direction of shortening of strata underlying Fernie, B.C. (see Fermor, 1999)

Active Structure - Mesoproterozoic



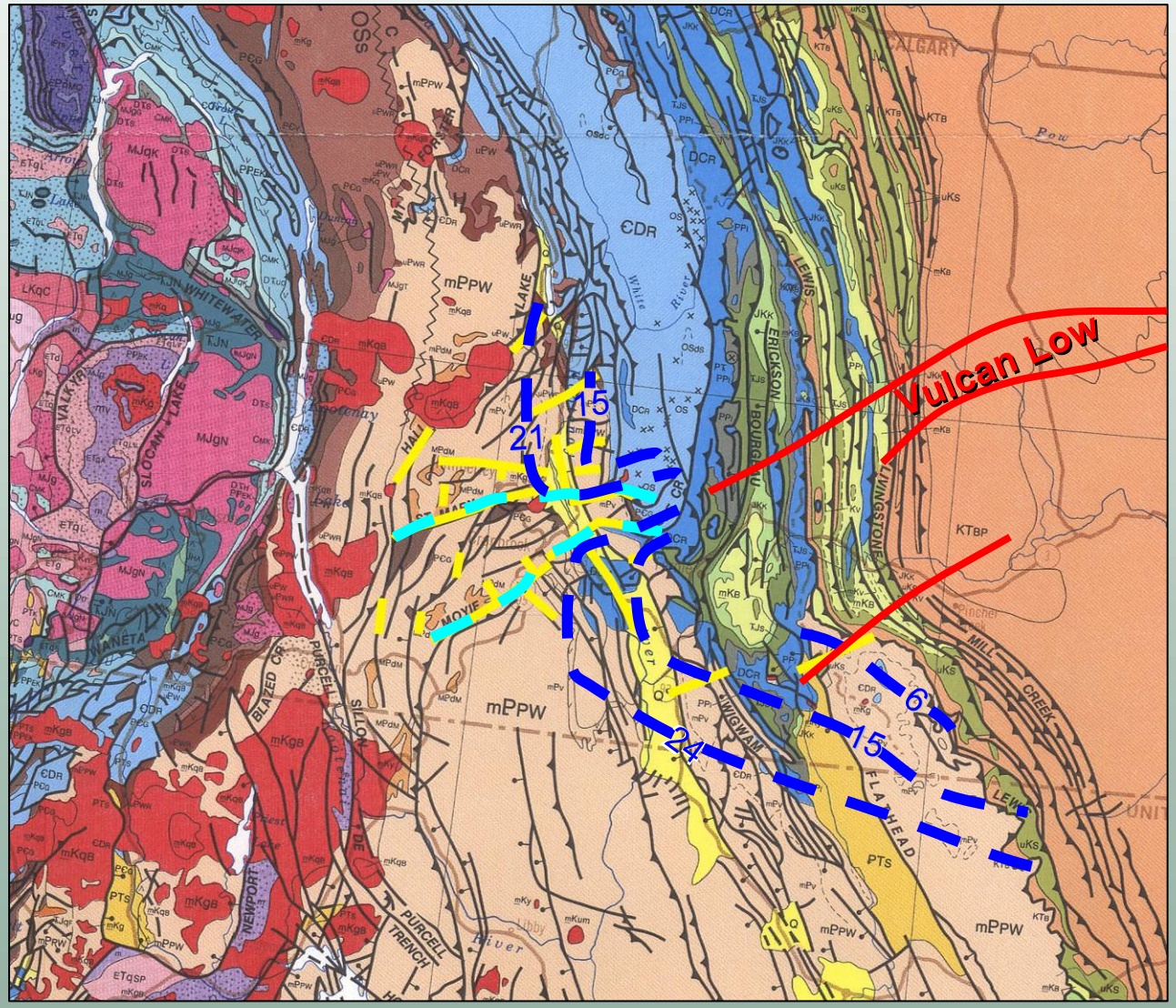
Antecendents of St. Mary - Boulder Creek and Moyie - Dibble Creek faults active Mesoproterozoic Belt-Purcell sedimentation

Note: active structures shown on this and several following maps are allochthonous relative to underlying basement

Mesoproterozoic Structure (modified after Hoy et. al., 2000)

Basement boundary

Active Structure - Mesoproterozoic

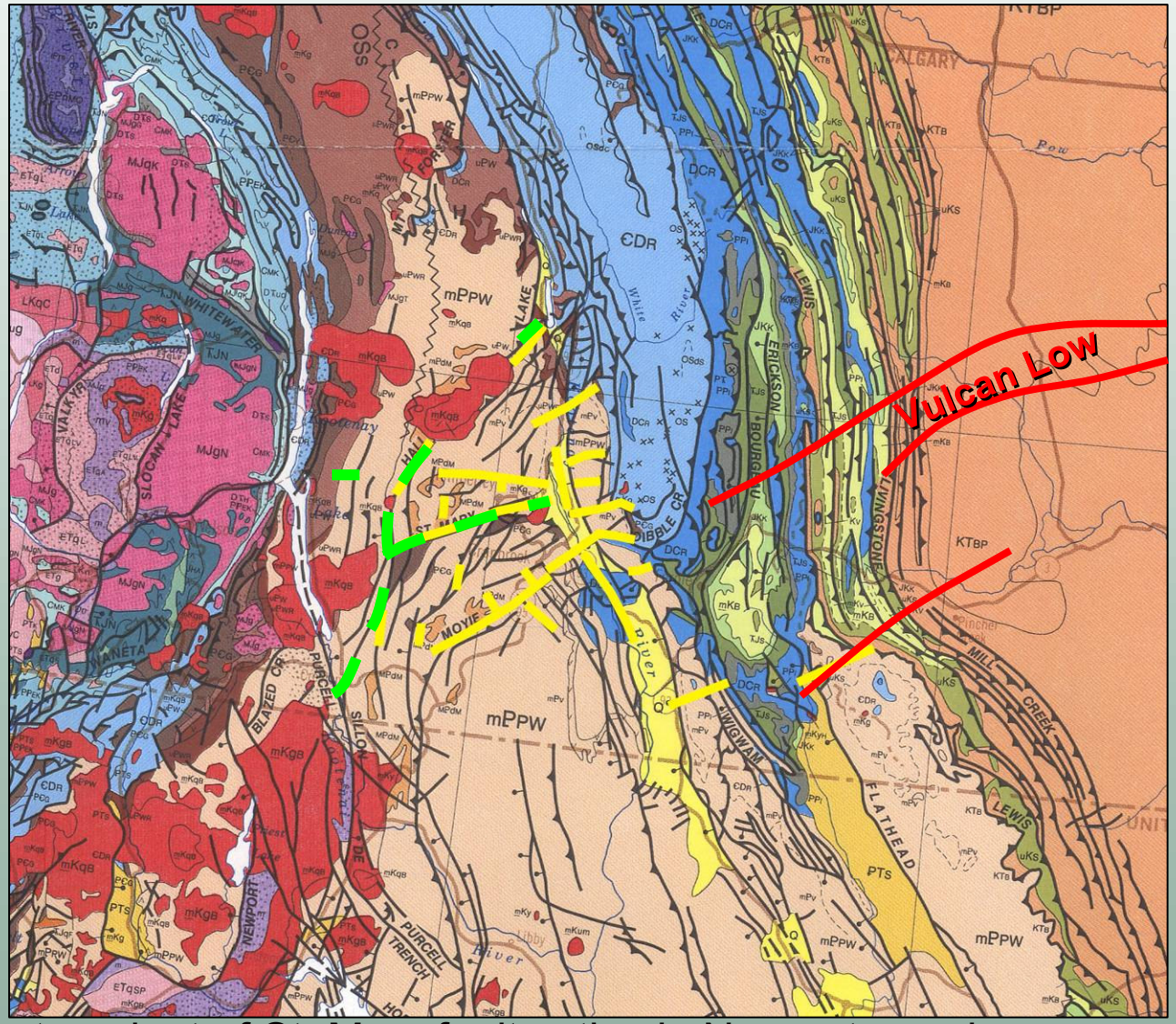


Antecedents of St. Mary-Boulder Creek and Moyie-Dibble Creek faults formed failed arm to main Belt-Purcell rift basin as indicated by isopach trends and facies (McMechan, 1981)

Mesoproterozoic Structure (modified after Hoy et al., 2000)

Lower Belt-Purcell isopach (in 100's of metres; after McMechan, 1981)

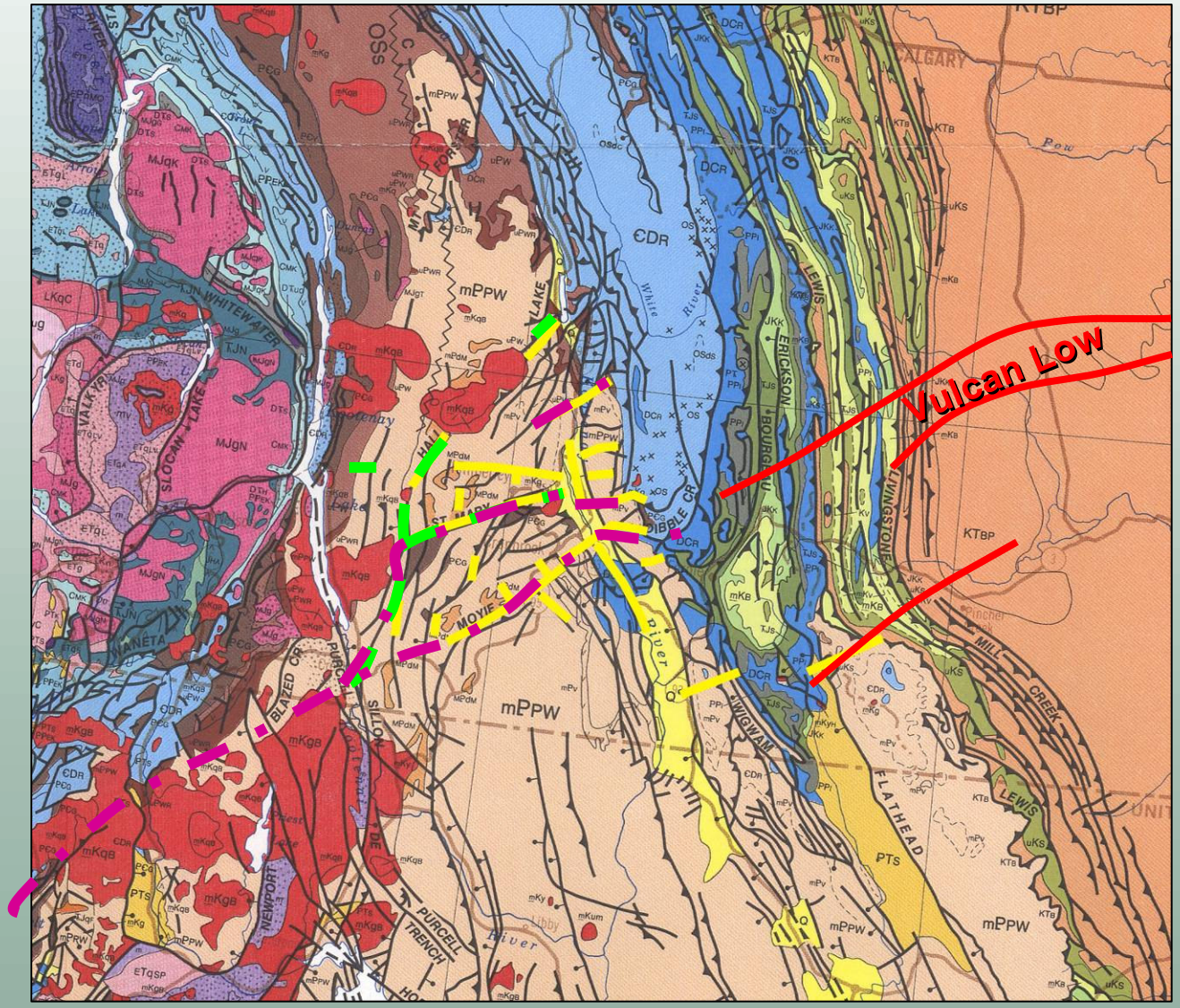
Active Structure - Neoproterozoic[3]



Antecedent of St. Mary fault active in Neoproterozoic

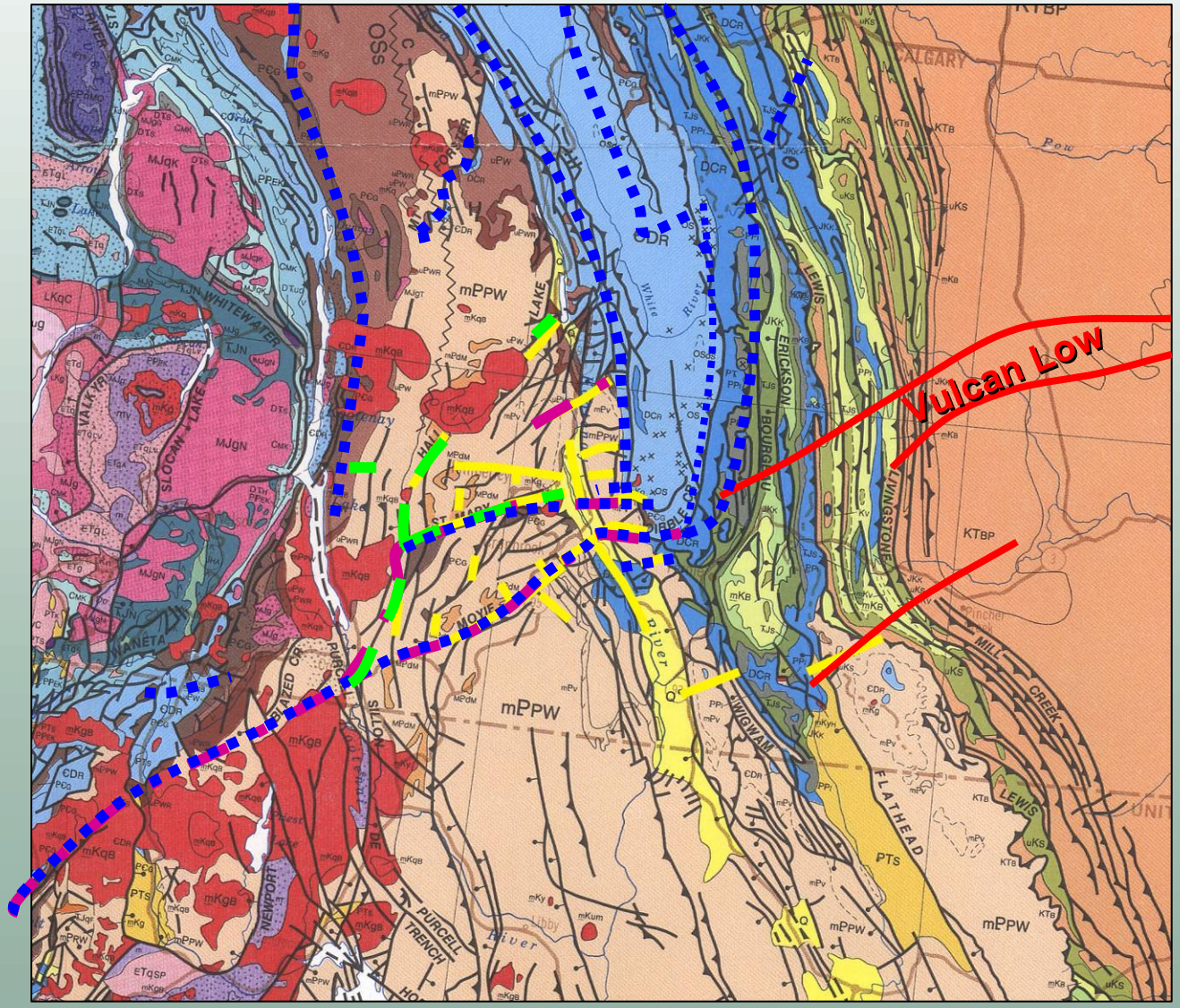
Stratigraphic record for Boulder Creek and Moyie-Dibble Creek faults removed by younger uplift

Active Structure - Sub-Cambrian [4]



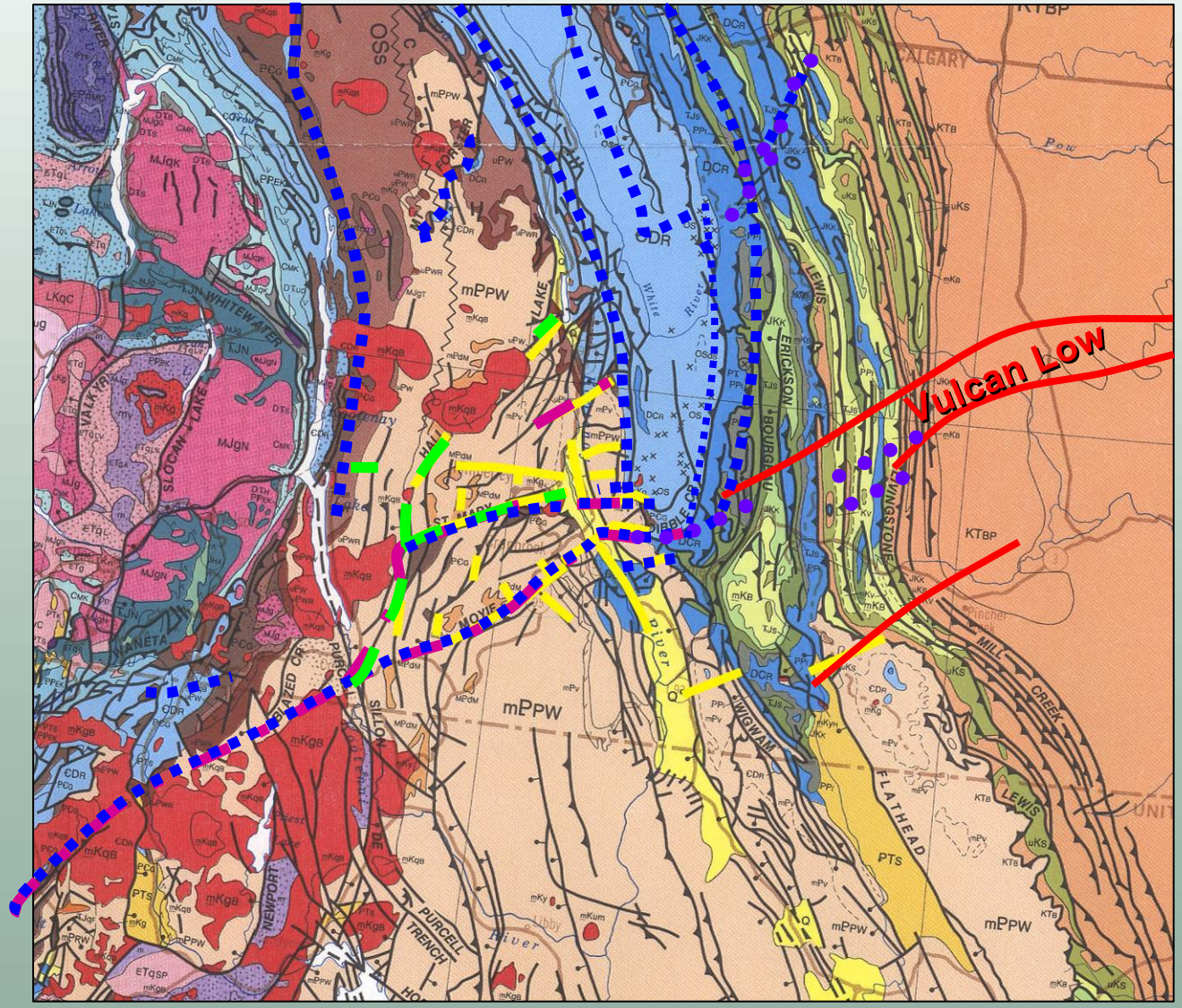
Antecedents of St. Mary- Boulder Creek and Moyie-Dibble Creek faults active prior to formation of sub-Cambrian unconformity

Active Structure - Lower Paleozoic[5]



Antecedents of St. Mary- Boulder Creek and Moyie-Dibble Creek faults active during Lower Paleozoic

Active Structure - Upper Paleozoic [6]



Record of activity mainly preserved in Front Ranges above Vulcan Low basement structure

-Mesoproterozoic

-Neoproterozoic

-Sub-Cambrian

-Lower Paleozoic

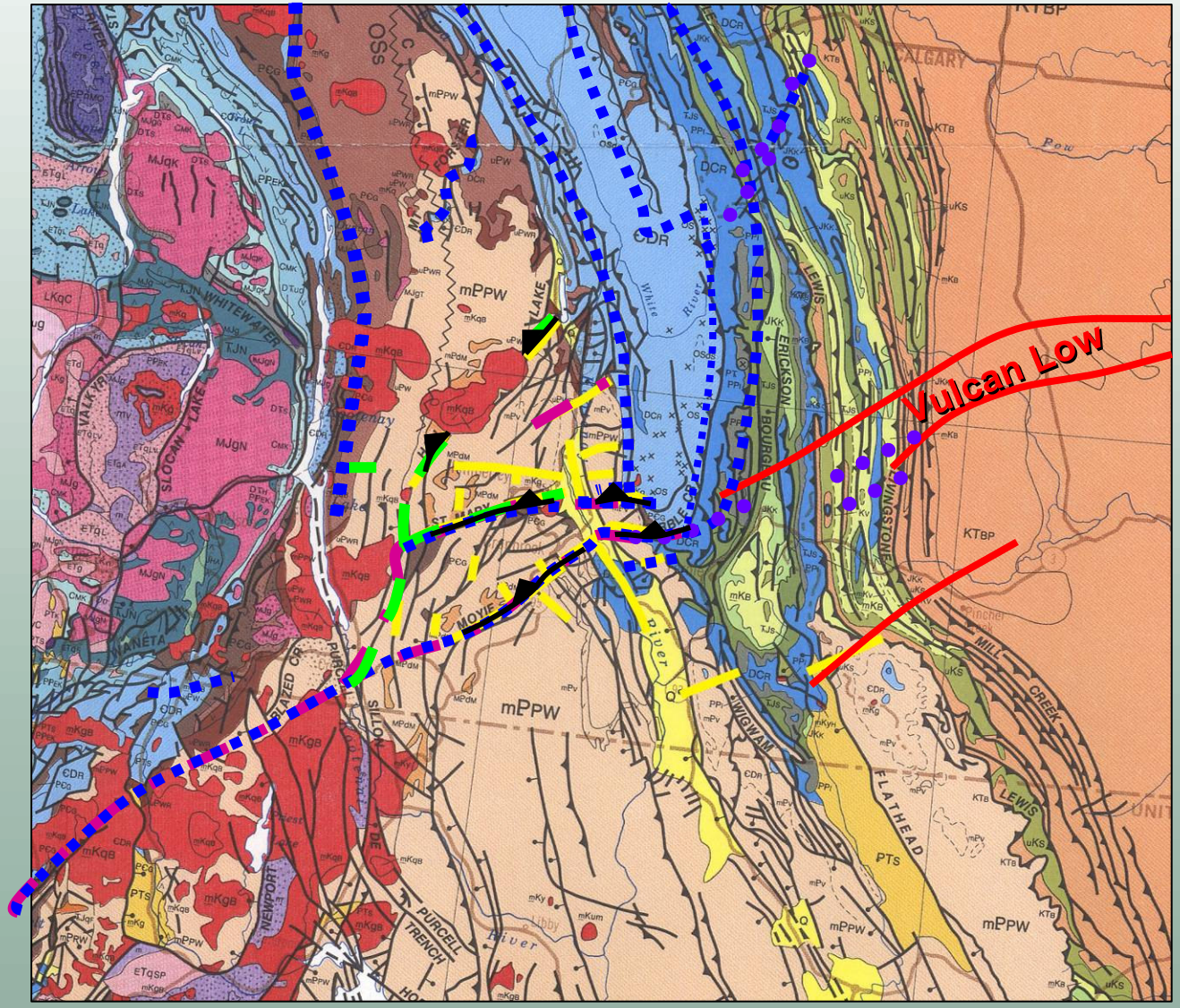
-Upper Paleozoic

Basement boundary

Antecedent of Dibble Creek fault active during Upper Paleozoic

Stratigraphic record for St. Mary- Boulder Creek and Moyie faults not preserved

Active Structure – Latest Jurassic - Eocene Compressional Deformation



Basement boundary

-Mesoproterozoic

-Neoproterozoic

-Sub-Cambrian

-Lower Paleozoic

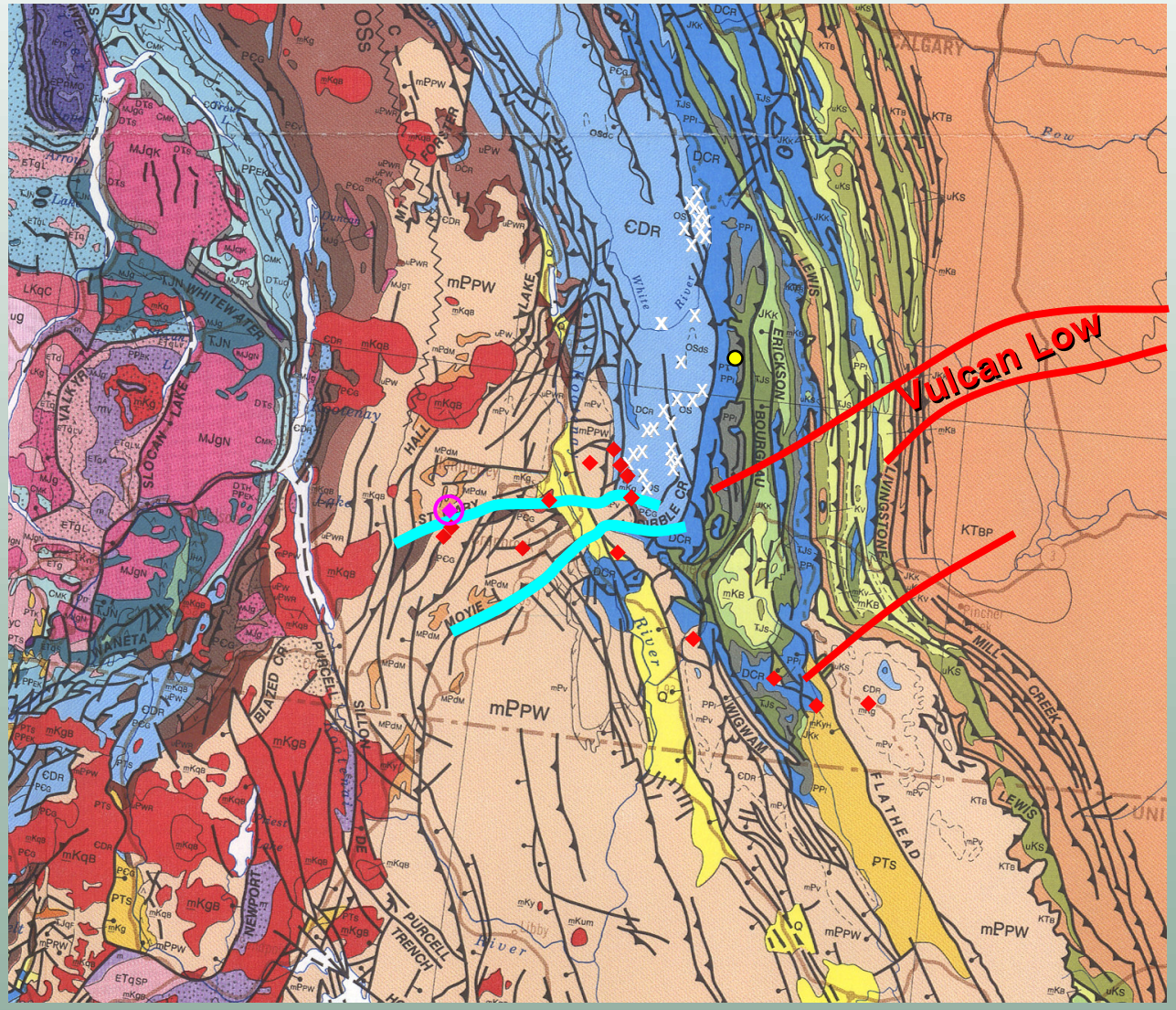
-Upper Paleozoic

-Upper Jurassic - Eocene compressional deformation

Transverse structures aligned with Vulcan Low episodically active from Archean to Cretaceous

Structures extend across the width of the fold and thrust belt

Intrusions[7]



Granitic intrusions uncommon in Rocky Mountains and eastern Purcell Mountains

Most Cretaceous granitic intrusions occur near old transverse structures in vicinity of Vulcan Low

Line types as on page 9

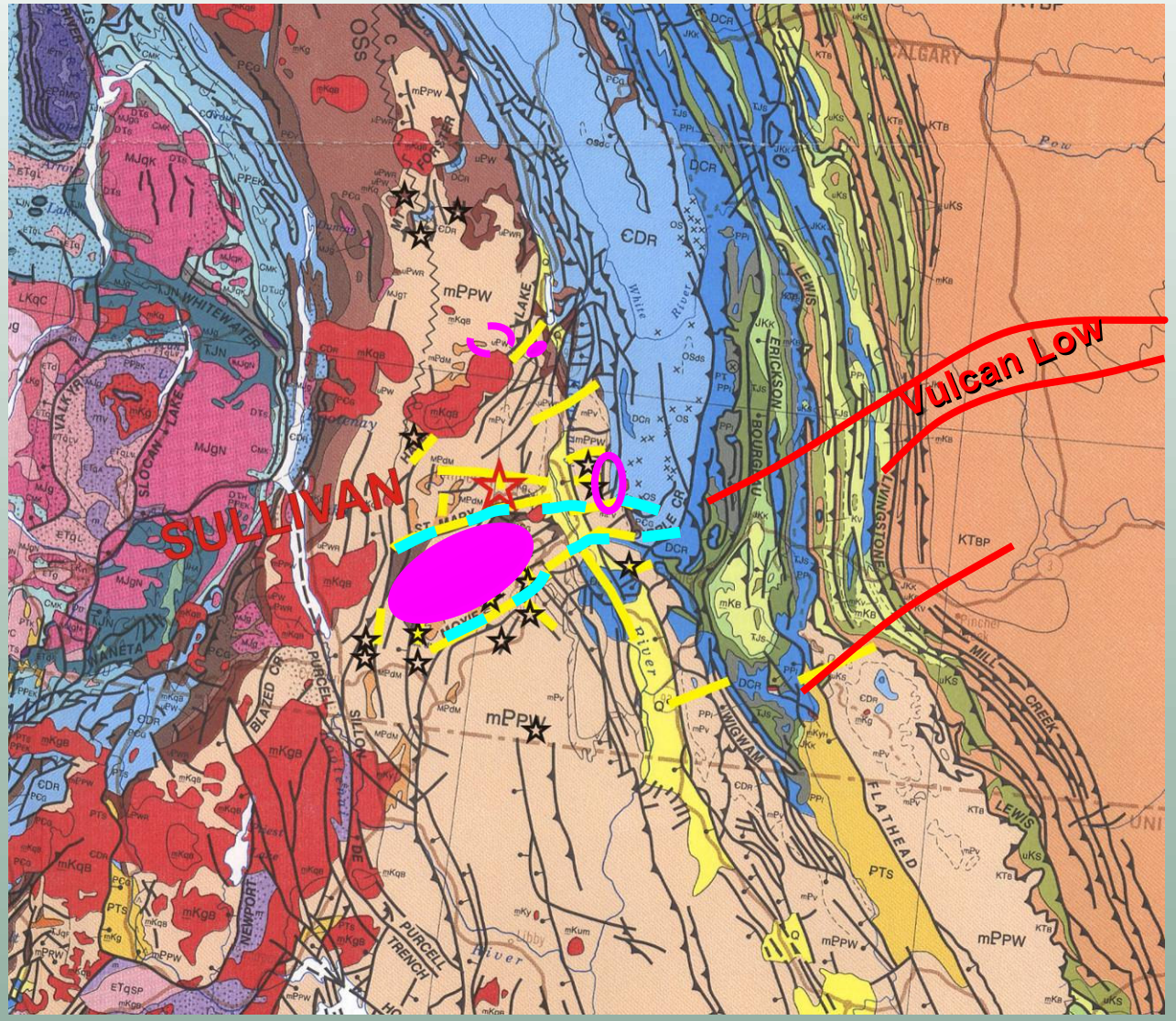
~1360 Ma Hellroaring CK stock

Ordovician-Middle Devonian diatreme breccia

Post-Pennsylvanian kimberlite

Mid-Cretaceous granitic intrusion

Mineral Deposits in Belt-Purcell Strata[8]



Concentrated near Vulcan basement structures

Syn-sedimentary Pb-Zn

-localized by rift-parallel and transverse structures (Hoy et al., 2000)

Au

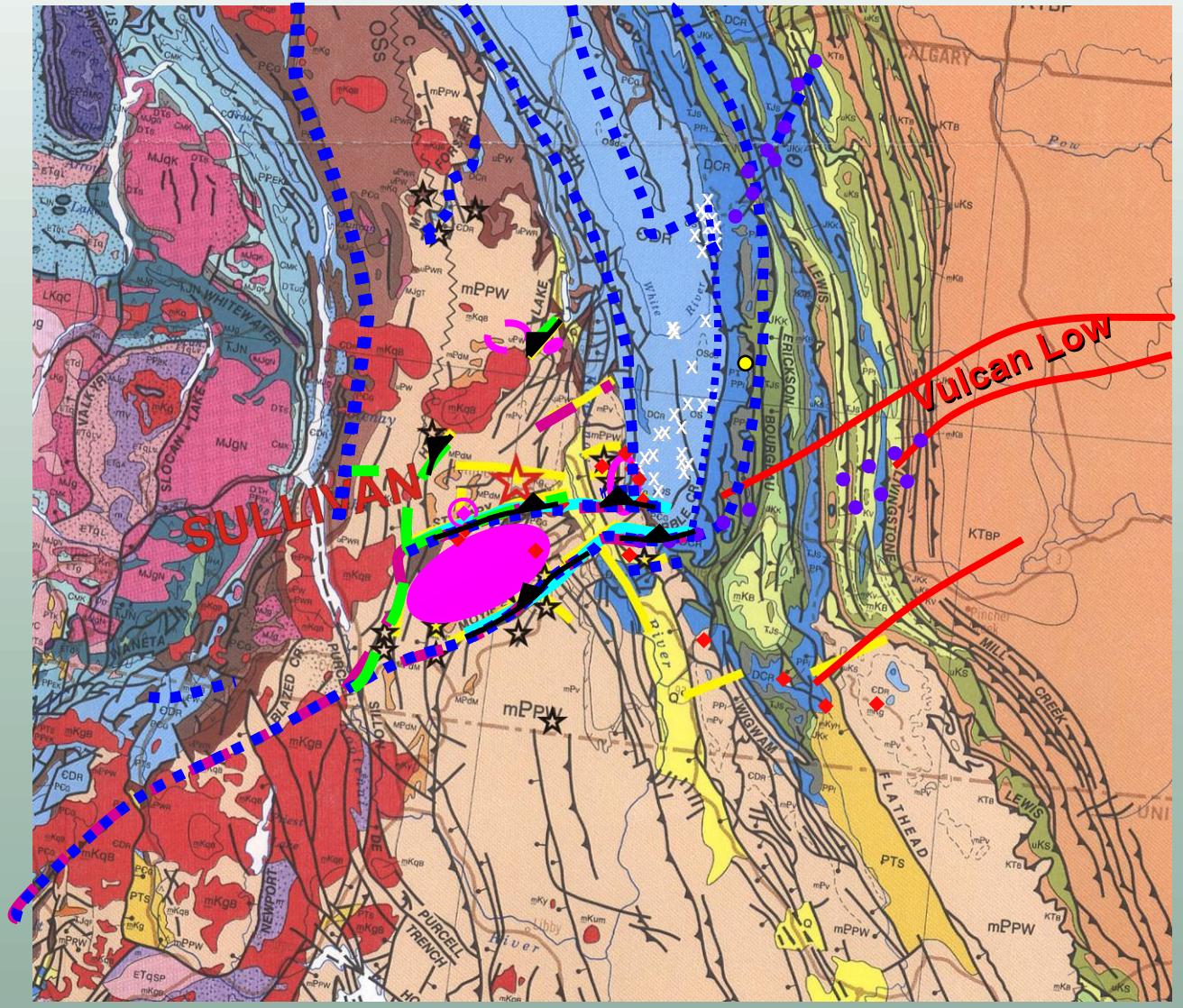
– in areas near intrusions

-vein gold localized by Mesozoic oblique-slip along early transverse structures (Thompson, R.I. unpublished talks 2009)

☆ base metal ○ placer gold ● vein gold

Line types as on p. 10

Vulcan Low Exploration Tool Box For Basement Structural Control



transverse structures aligned with Vulcan Low have

-long, episodic geological history

- occur across width of belt

-localized mineralization

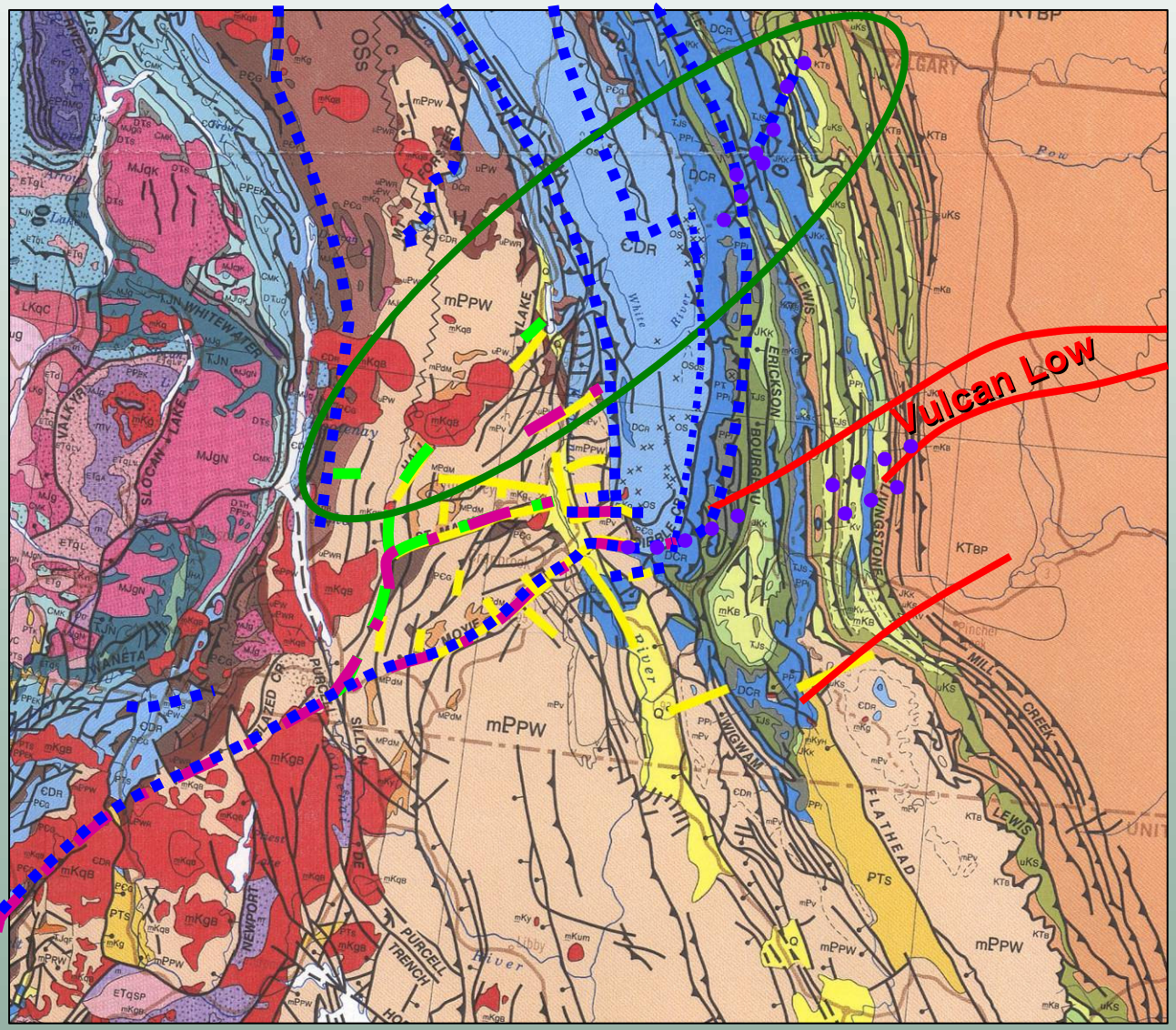
-localized intrusions

- Kimberlite
- x Diatreme breccia
- Cretaceous granitic intrusion

☆ base metal placer gold vein gold

Line types as on page 16

Northern Zone - Active Structures



Northern set of transverse structures not aligned with Vulcan Low have:

- -long episodic geological history
- - occur across width of belt
- -will examine in more detail on following pages

Basement boundary

Mesoproterozoic

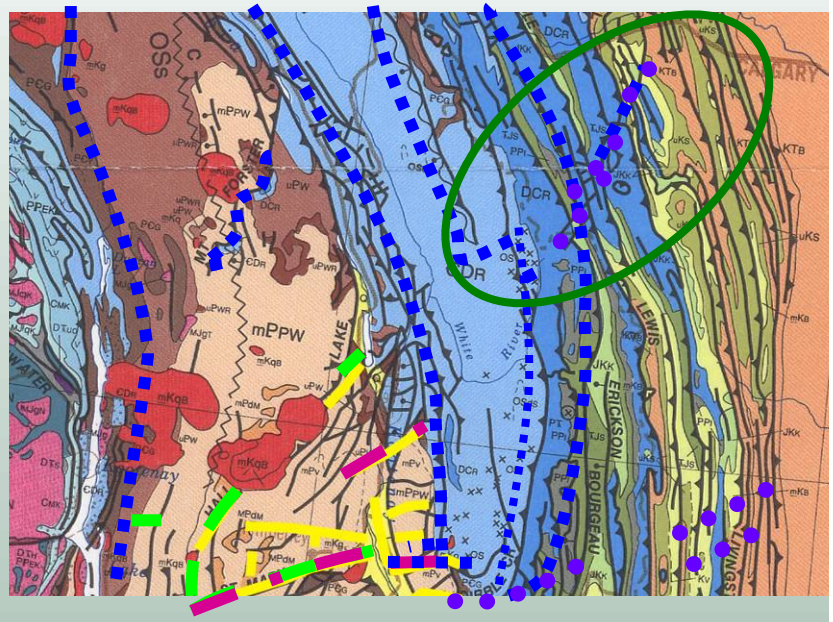
Neoproterozoic

Sub-Cambrian

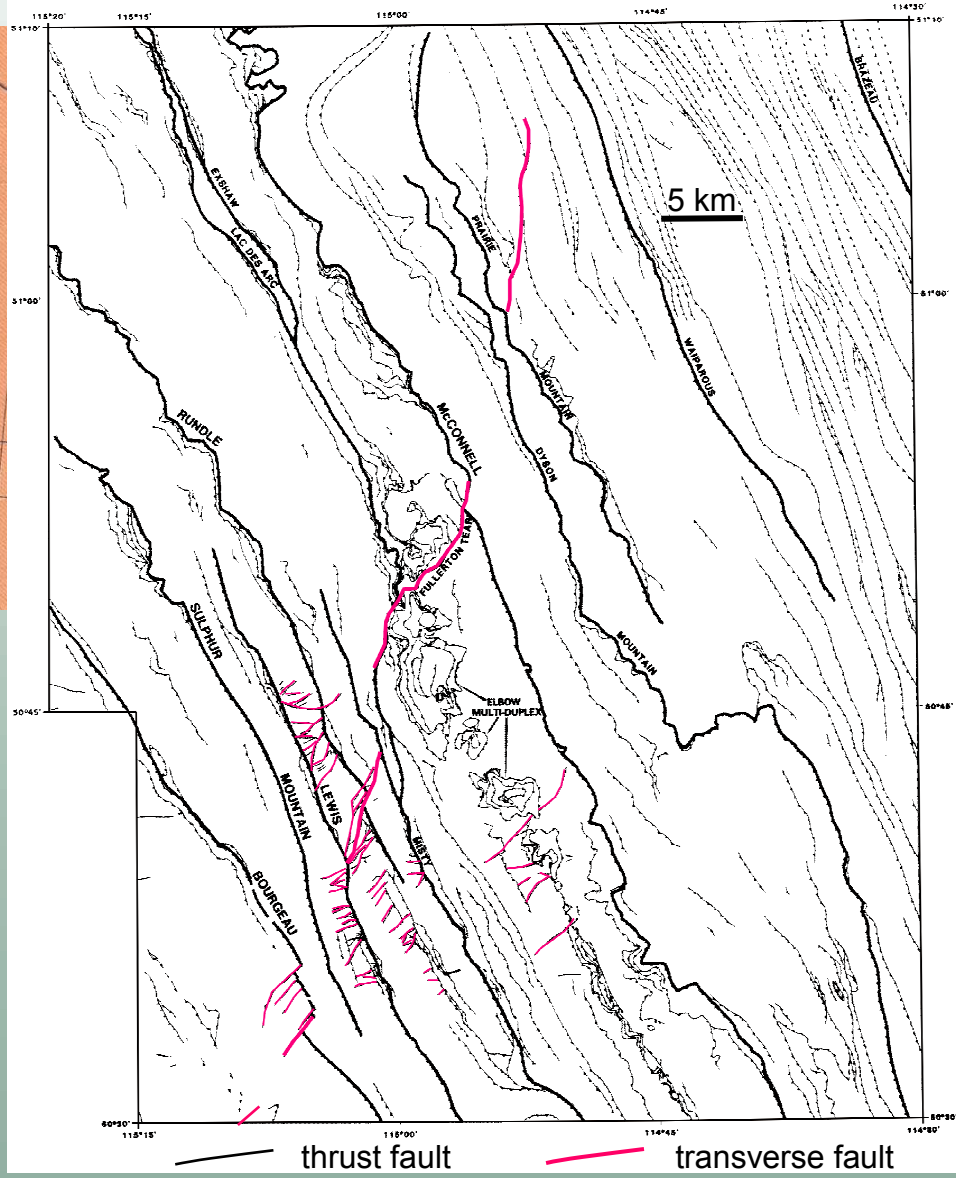
Lower Paleozoic

Upper Paleozoic

Eastern Transverse Faults

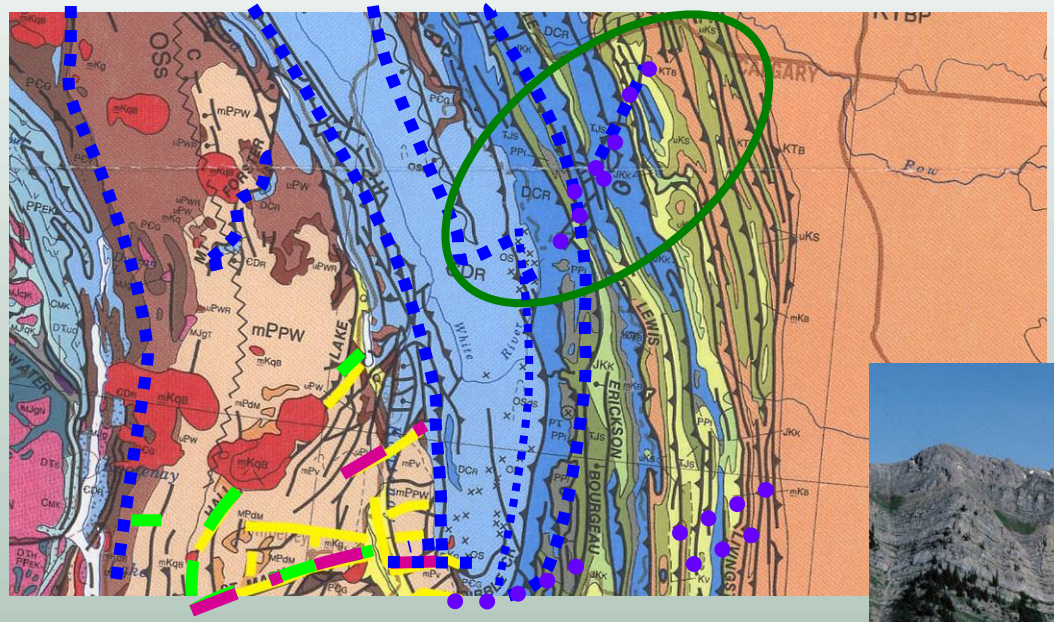


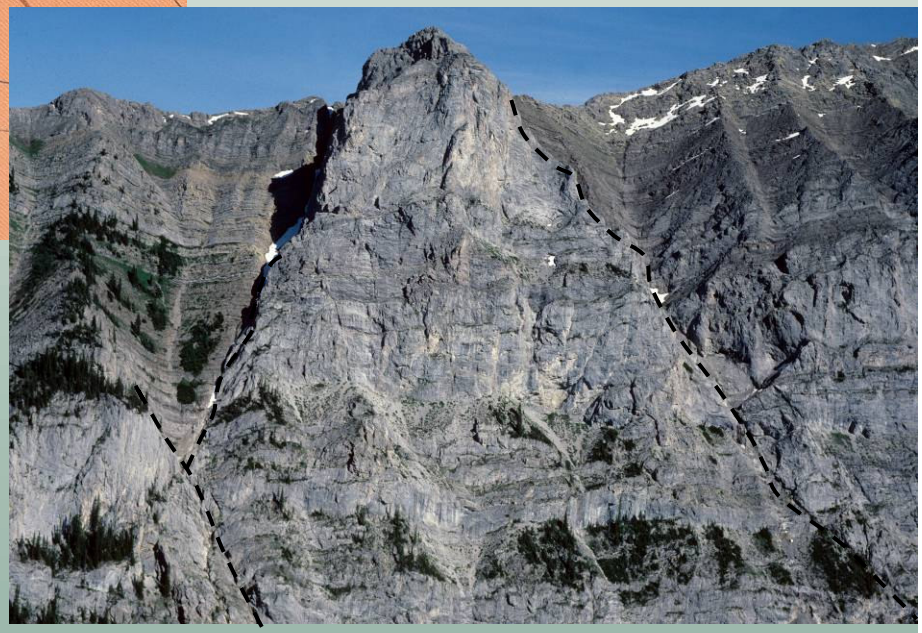
-Cut across fold and thrust belt structural grain



Distribution of faults in eastern Rocky Mountains and Foothills southwest of Calgary, Alberta (after McMechan, 1995)

Eastern Transverse Faults



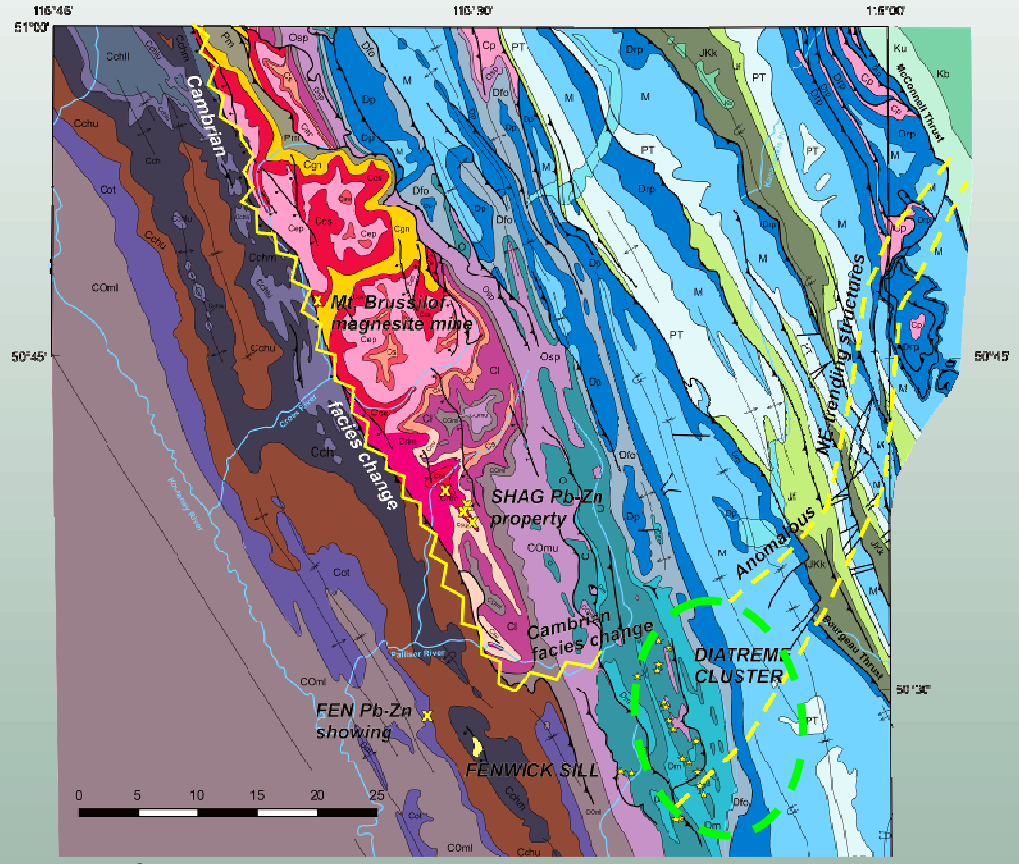


Transverse faults in hangingwall of Lewis Thrust sheet in Mississippian Rundle Group strata

-Cut across thrust belt structural grain

-Originated as normal faults that affected Cambrian, Devonian, Mississippian and/or Triassic sedimentation (Bielenstein,1969; Sanderson, 1998; McMechan, 2001)

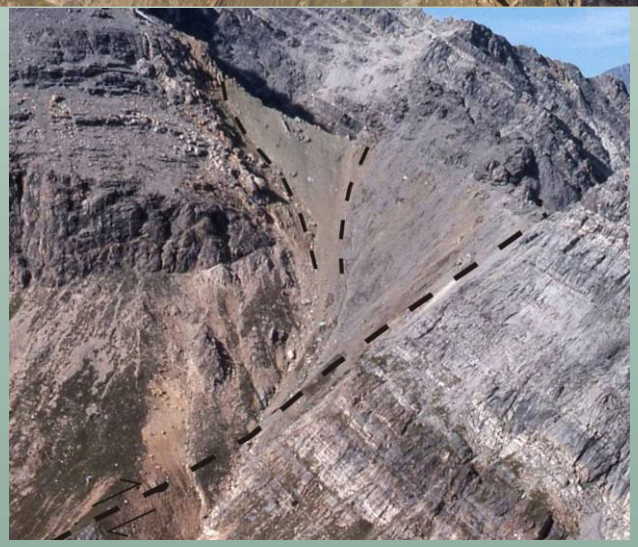
Diatreme Cluster



Map after McMechan (1995), McMechan and Leech (2010a,b), McMechan and Mott (2010), McMechan (unpublished)

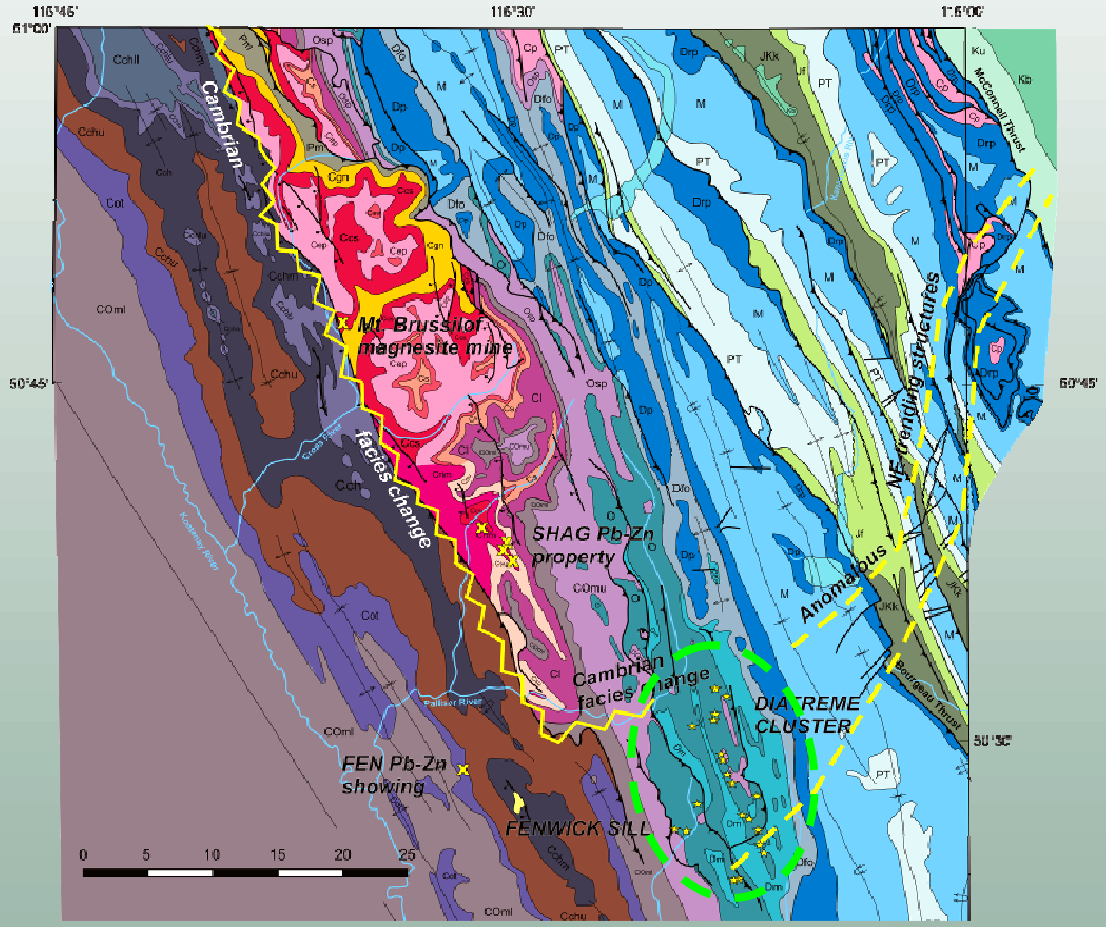
-occurs at southwest end of zone of reactivated, anomalous northeast-trending faults

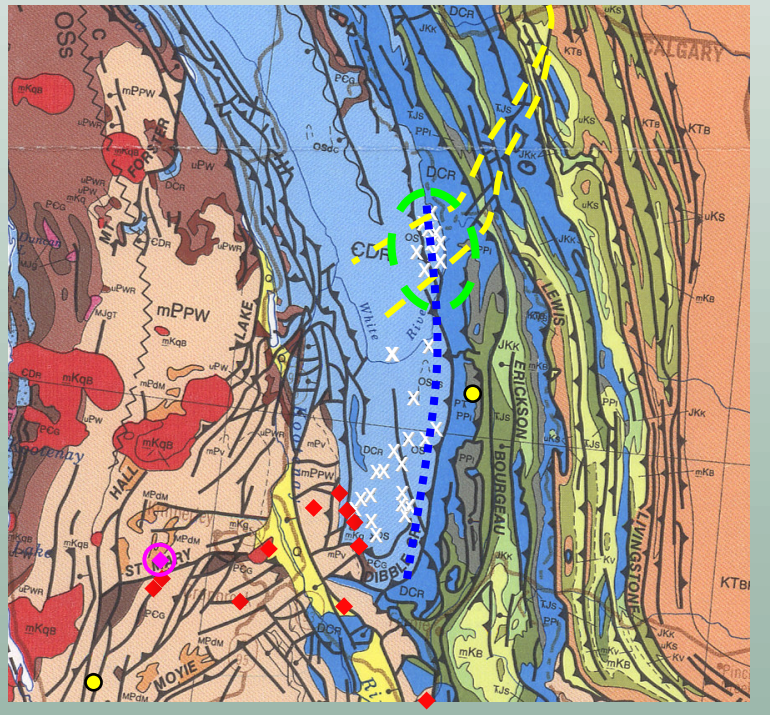
-Late Ordovician and pre-Middle Devonian intrusion



Diatreme on south arm of Russell Peak. Intruded along and offset by old northeast-trending fault

Diatreme Cluster





deep-seated basin parallel structure

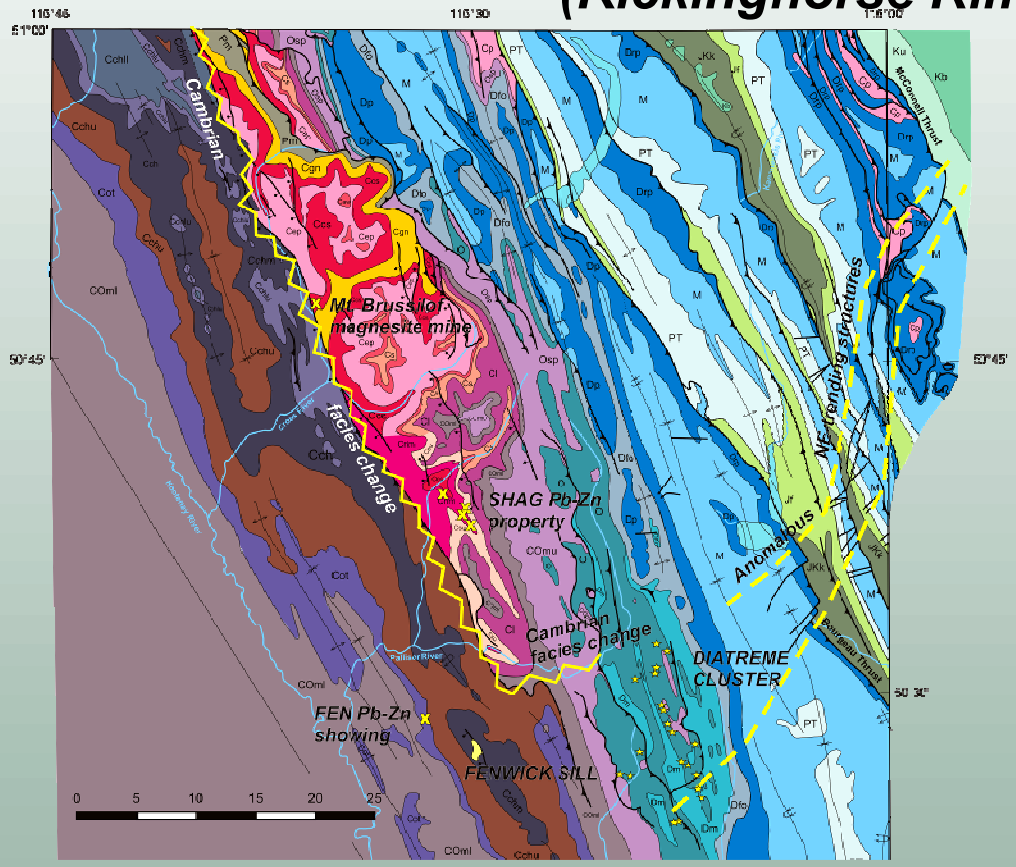
Transverse structural zone

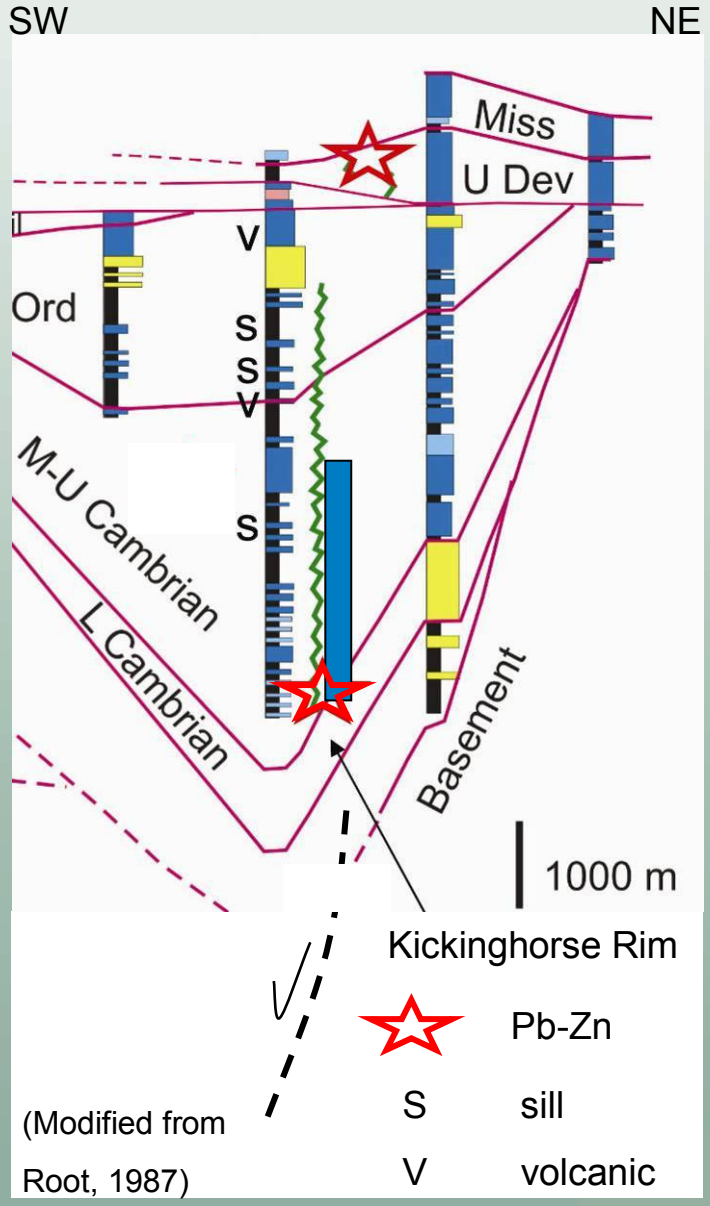
-Have a deep source (Pell, 1994)

-Localized where deep basin parallel structures overlap transverse structural zone

Intrusion symbols as on page 17

Middle Cambrian to Middle Ordovician Facies Change (Kickinghorse Rim)

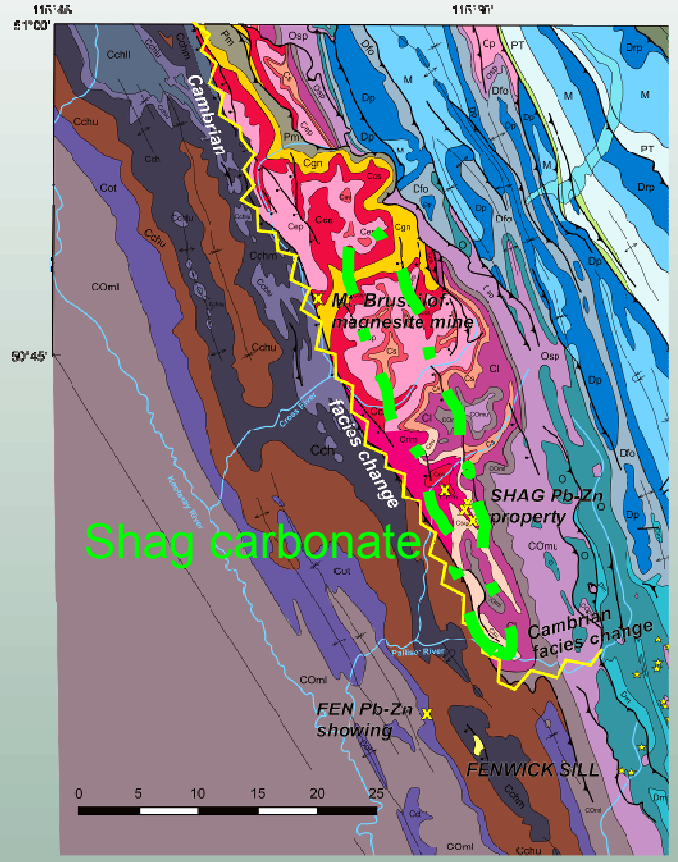


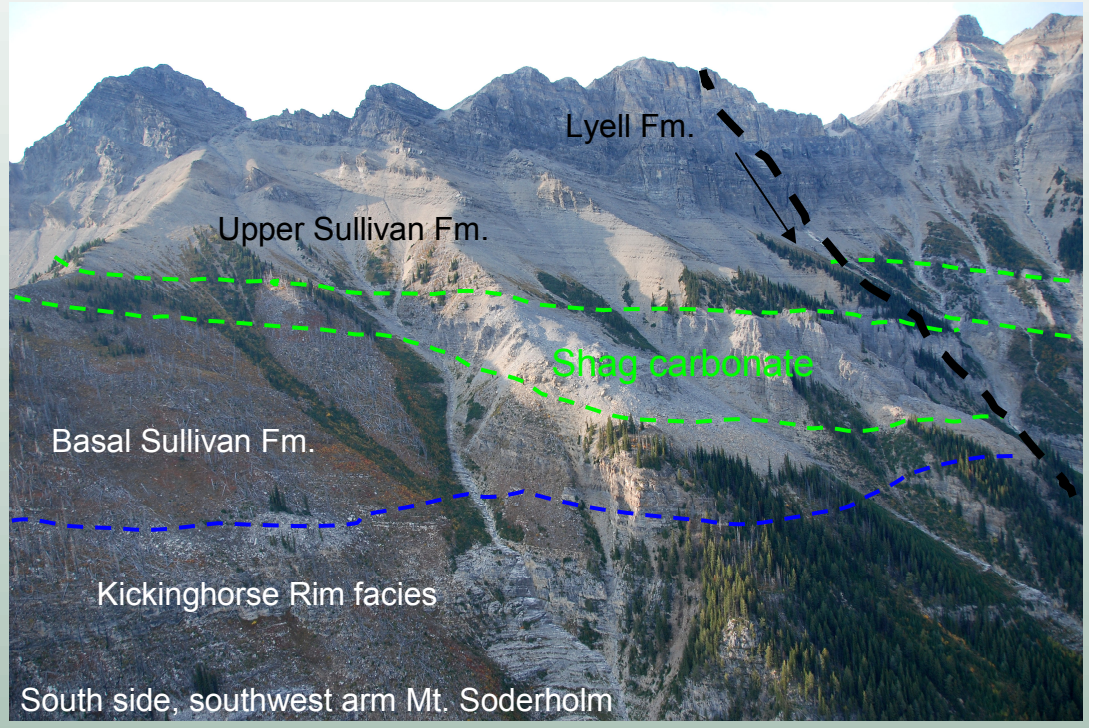


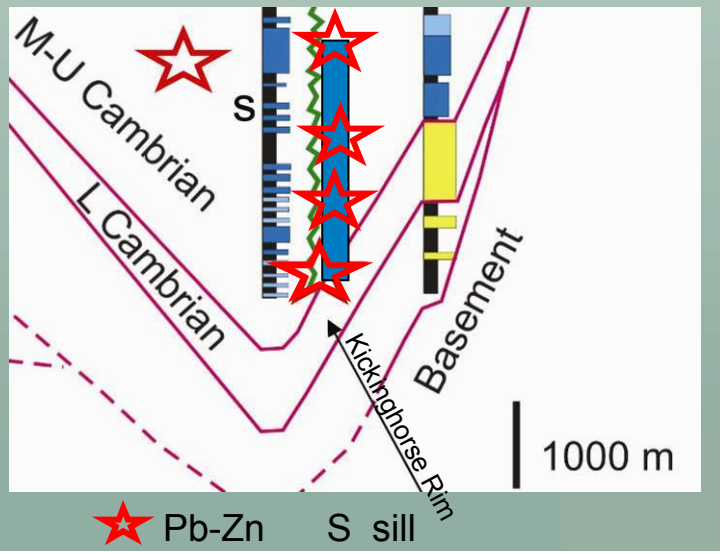
-Structurally controlled

-In most areas extensive dolomitization of Middle Cambrian strata at Rim with mineralization at Cathedral margin

At South End Cambrian Kickinghorse Rim





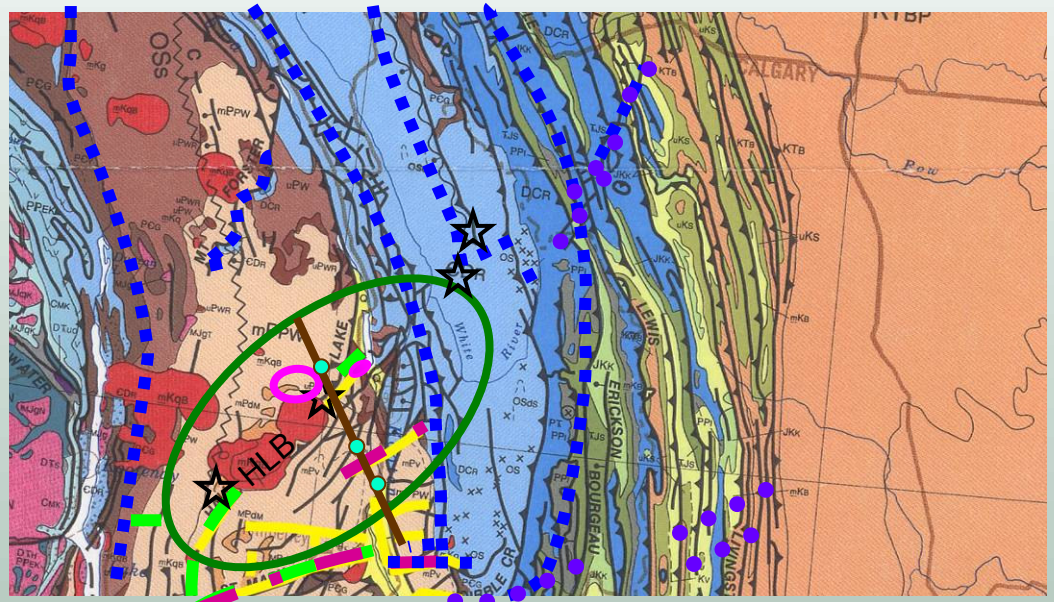


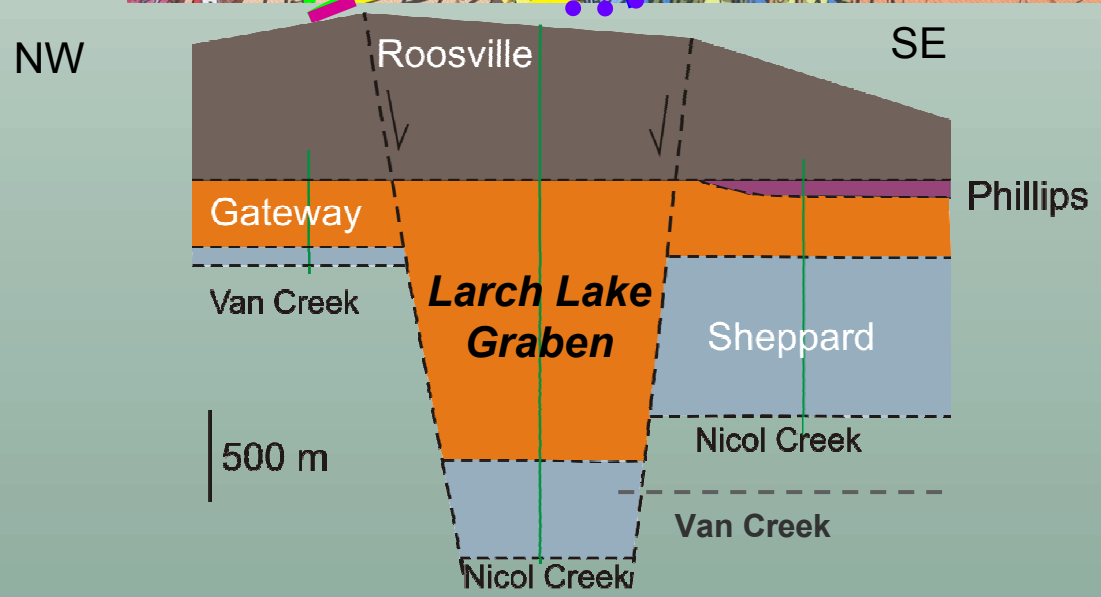
-Localized shallow water carbonate developed above normal Rim facies in Upper Cambrian Sullivan Formation

- -mineralized at top on Shag property
- -indicates uplift at southeastern end of Kickinghorse Rim

-mineralization at several stratigraphic levels of extensively dolomitized Middle and Upper Cambrian Rim

Western Transverse Faults





Mesoproterozoic Upper Purcell stratigraphic section
(Revised from Gardner, 2008)

Paleo-Hall Lake fault active during deposition of:

-Mesoproterozoic

-Neoproterozic

-Formed north boundary upper Purcell (post 1445 Ma) Larch Lake graben (Gardner, 2008)

-South boundary active in sub-Cambrian

-Hall Lake batholith (HLB) intruded along Hall Lake fault

Some associated mineral deposits

Pb-Zn

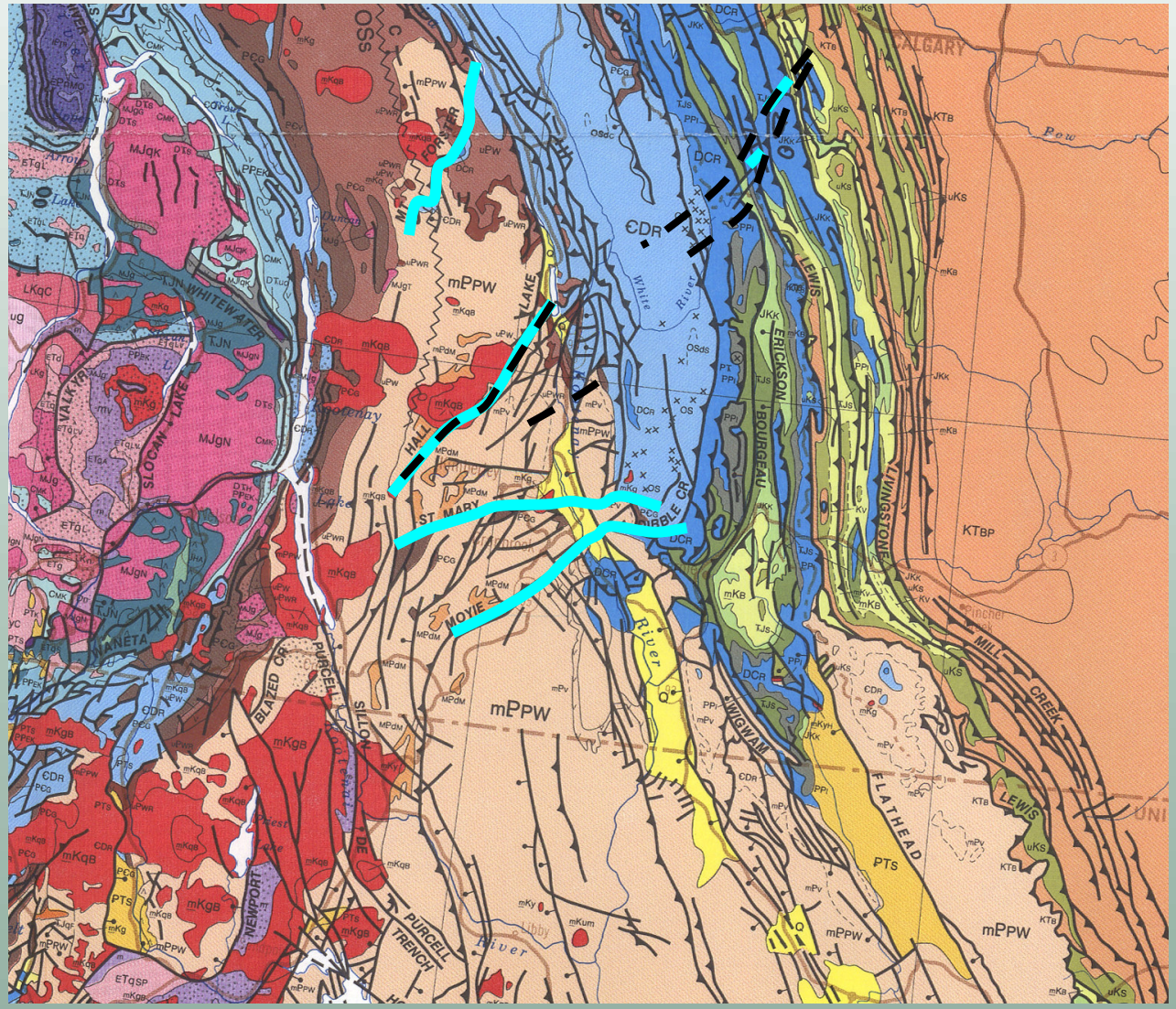
Vein Au

Placer Au

Location of stratigraphic section with control sections

Other line types as on page 9

Northern Transverse Zone - Summary



North zone long history of intermittent activity

-Controlled major facies changes in Cambrian/Ordovician and Mesoproterozoic (Upper Purcell)

-Localized intrusions

-Enhanced mineralization

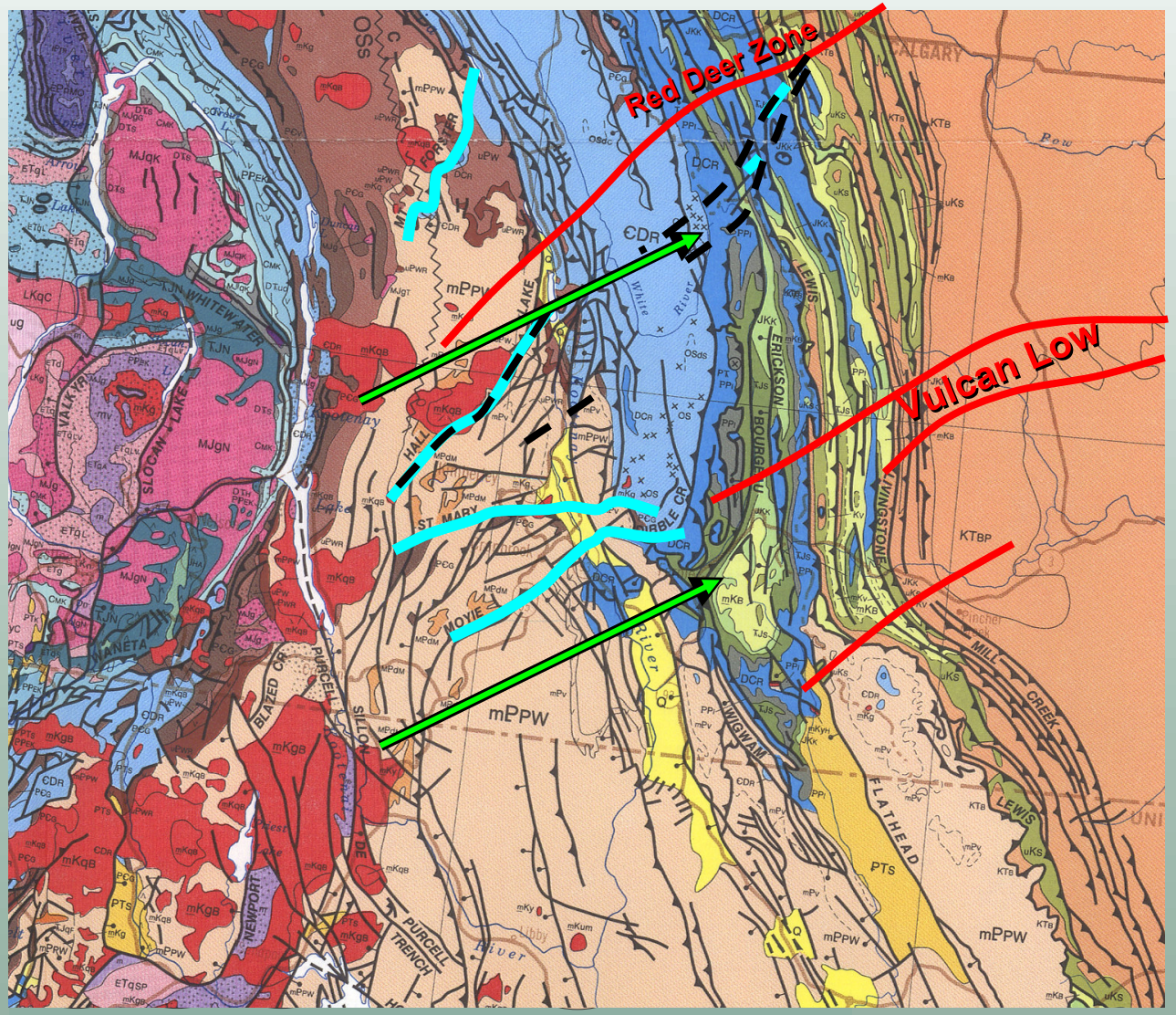
-***Features similar to Vulcan Low zone***

-Suggests related to basement structure

Transverse fault

Northern zone transverse fault zones

Relationship to Basement Boundaries



Transport direction of thrust faults in Rockies as determined from seismic data and tear faults (Fermor, 1999; McMechan 2001) is:

-subparallel to Vulcan Low and southern transverse faults

-oblique to northern transverse fault zone

-need to palinspastically restore northern zone features to original position

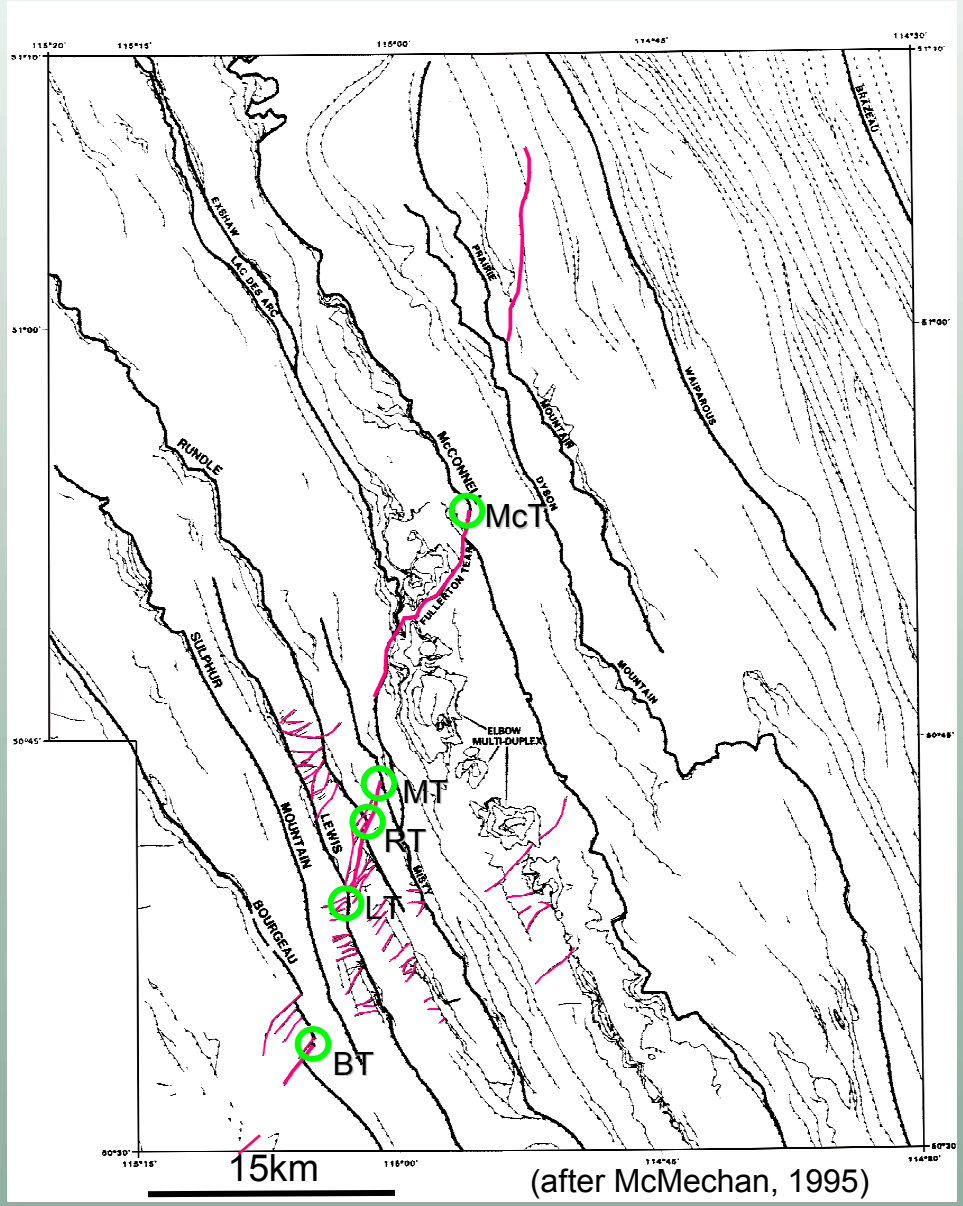
Transport direction

Transverse fault

Northern zone transverse fault zones

Basement boundary from aeromag

Palinspastic Restoration

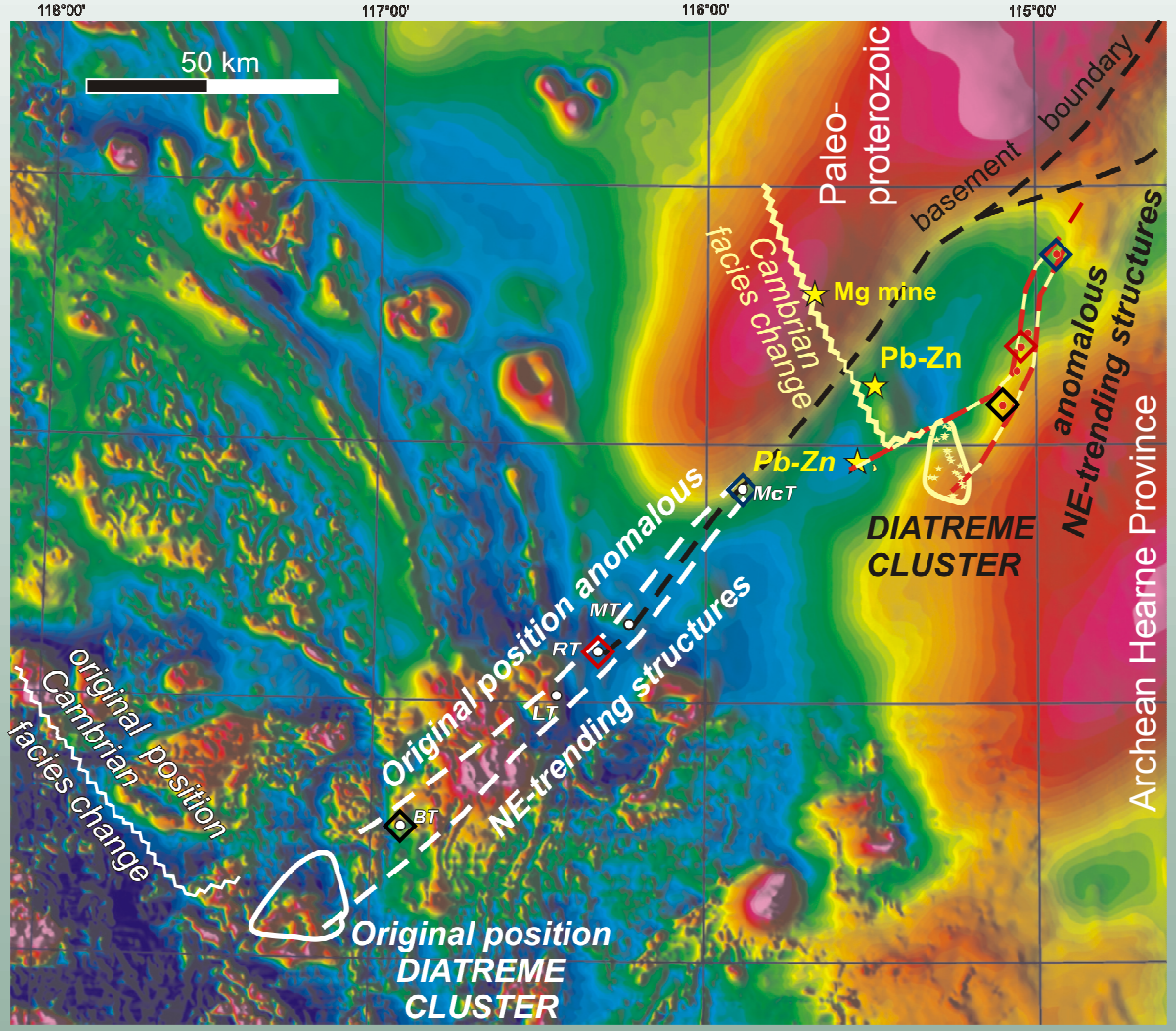


-Restoration of all the faults shown on this map based on balanced cross-sections constrained by seismic and well data (Fermor, 1999; McMechan, 1998)

-Localities restored are the points where an anomalous northeast-trending structure (see p. 21-22) intersected the leading edge of each of the major thrust sheet (McConnell (McT), Misty (MT), Rundle (RT), Lewis (LT), Bourgeau(BT)) in the Rocky Mountains

Current position of locality restored

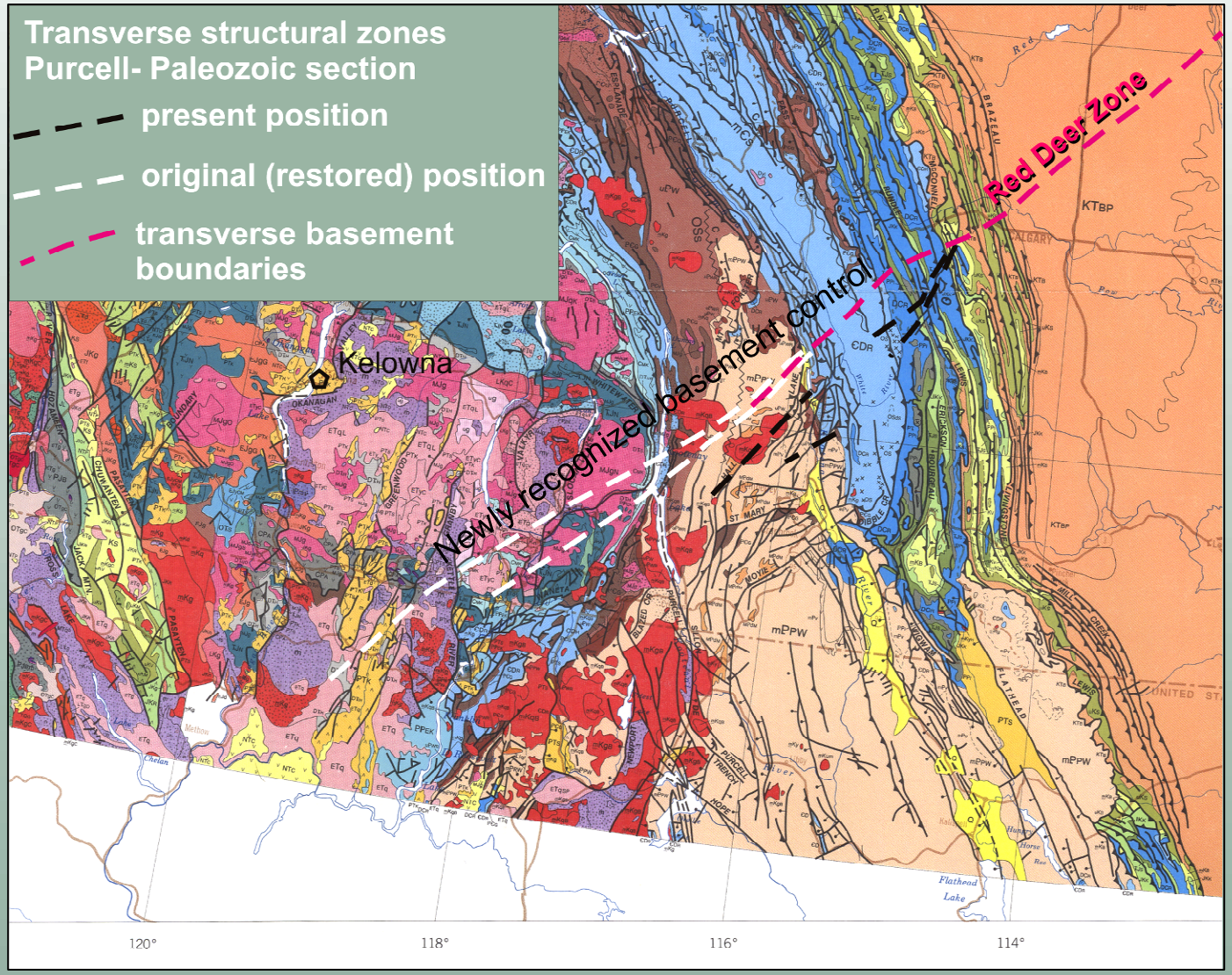
Palinspastic Restoration East Part Northern Zone



Anomalous structures at leading edge of McConnell (McT), Misty (MT) and Rundle (RT) thrusts (p. 30) restore directly over the Red Deer zone, the transverse basement boundary (Hope and Eaton, 2002) at marks the northwest end of the Archean Hearne Province

Anomalous tranverse structures at the leading edge of the Lewis (LT) and Bourgeau (BT) thrusts (p. 30), the diatreme cluster, and the southeast end Cambrian facies change (Kickinghorse Rim) restore directly along on the projection of this zone

Red Deer (Northern) Zone



The Red Deer Zone forms the northwestern boundary of the Loverna Block of the Archean Hearne Craton (Hope and Eaton, 2002)

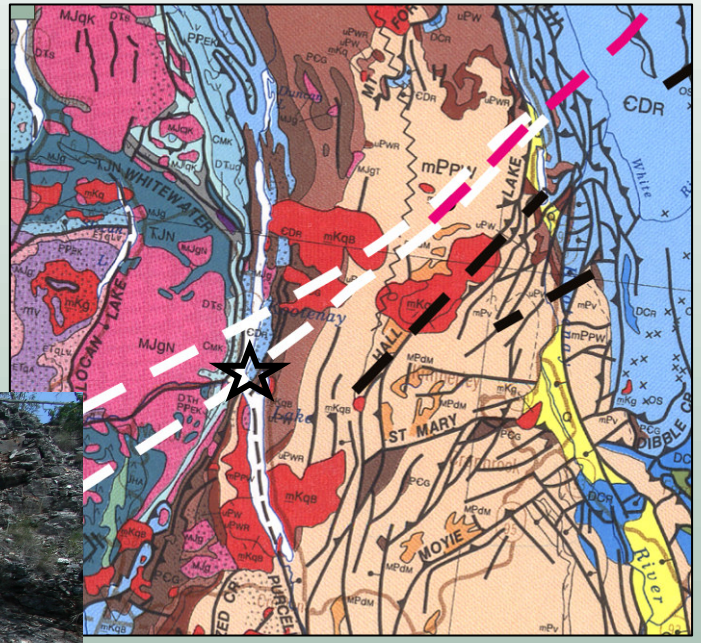
Palinspastic restoration of western structures[9] (Hall Lake fault, Larch Lake graben) shows:

Buried basement zone extends beneath Rocky Mountain Fold and Thrust Belt, Omineca Belt and Intramontaine Belt rocks into the United States

Red Deer (Northern) Zone Affected Tertiary Mineralization and Structures

-Bluebell Early Tertiary MTV deposit[10] and Lakeshore MTV deposit overlie buried, transverse basement boundary

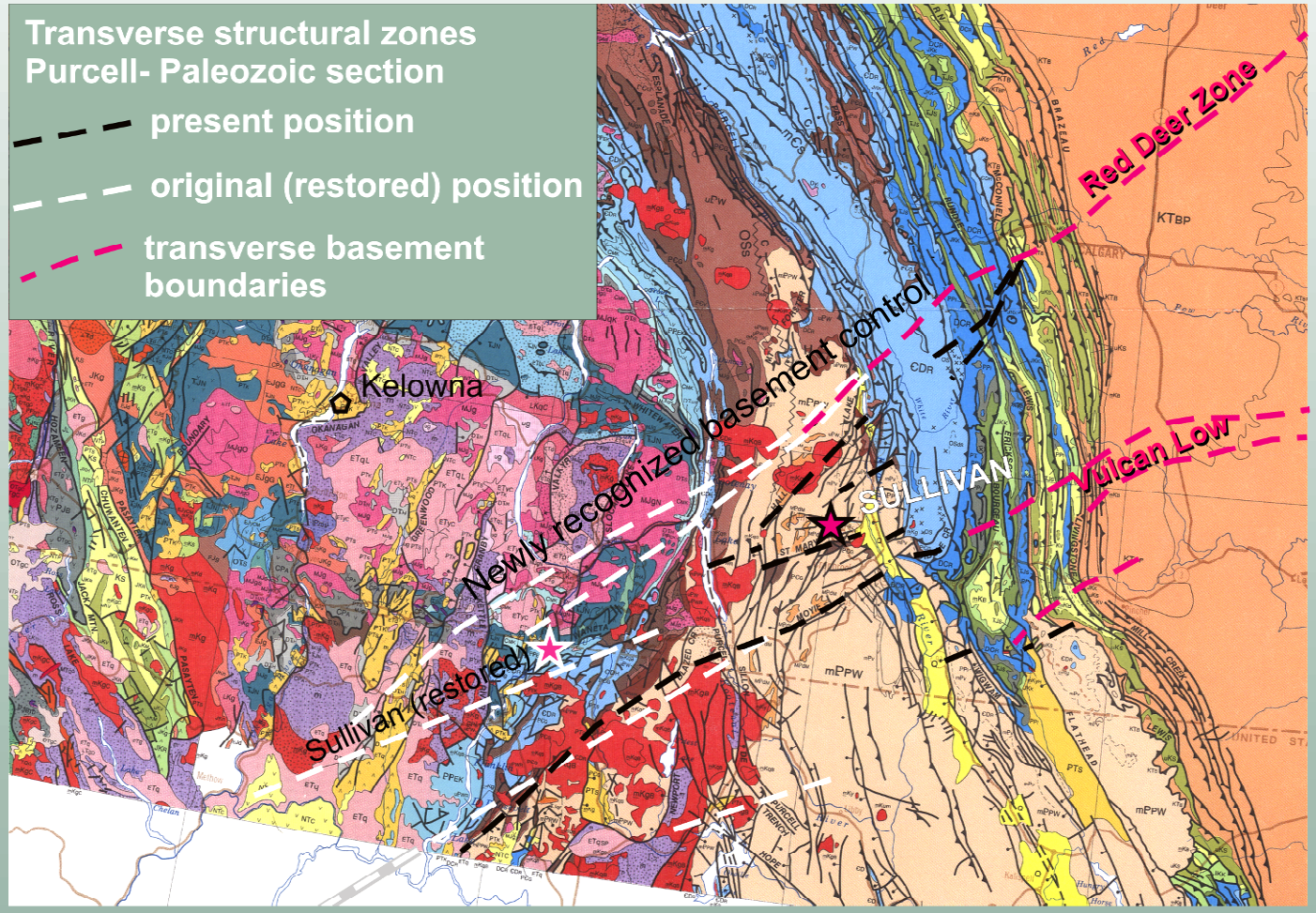
-Eocene normal faults underlying Kootenay Lake offset at zone (shown by jog in lake)



Bluebell Mine

Kootenay Chief Ore zone (photo courtesy of B. Richards)

Conclusions



Transverse basement structures localized

- thickness and facies changes

-intrusions

-mineralization

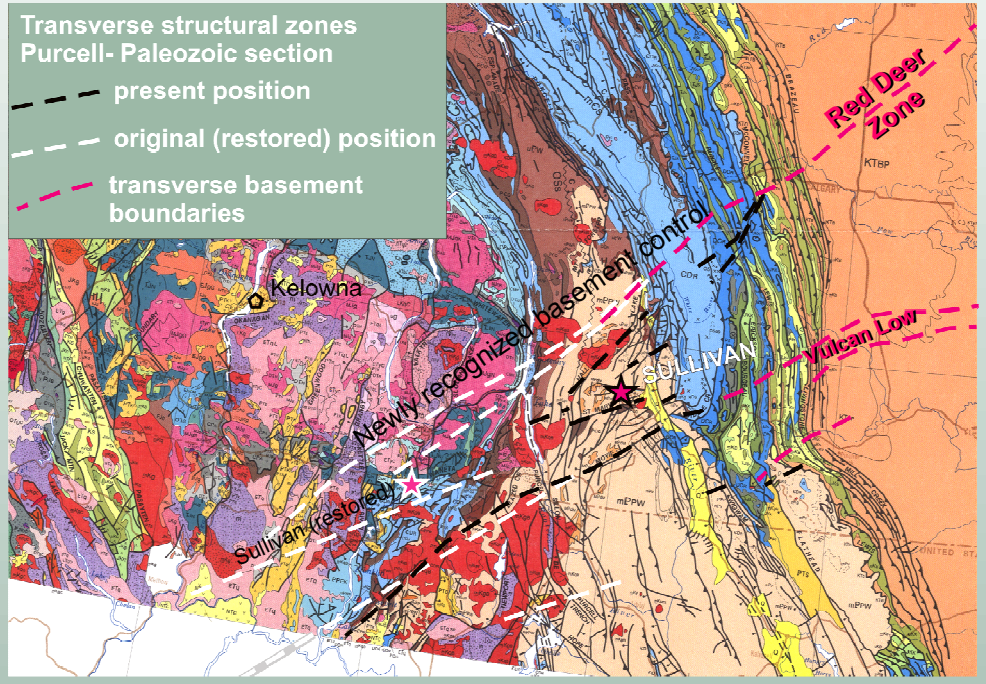
- Jurassic-Paleocene compressional structures

-Tertiary mineralization

and extensional structures

Exploration along exposed structures has been successful in the past
Exploration along buried and present traces may be fruitful in the future
Especially in known metallotects and where intersected by other faults

Conclusions – Exploration Targets – "Two for One"



- Each basement structure provides two exploration opportunities
  1. Along transported exposed structures
  2. Along buried original position. If structure formed mineralization pathway once could it form a pathway for Tertiary mineralization and intrusion?

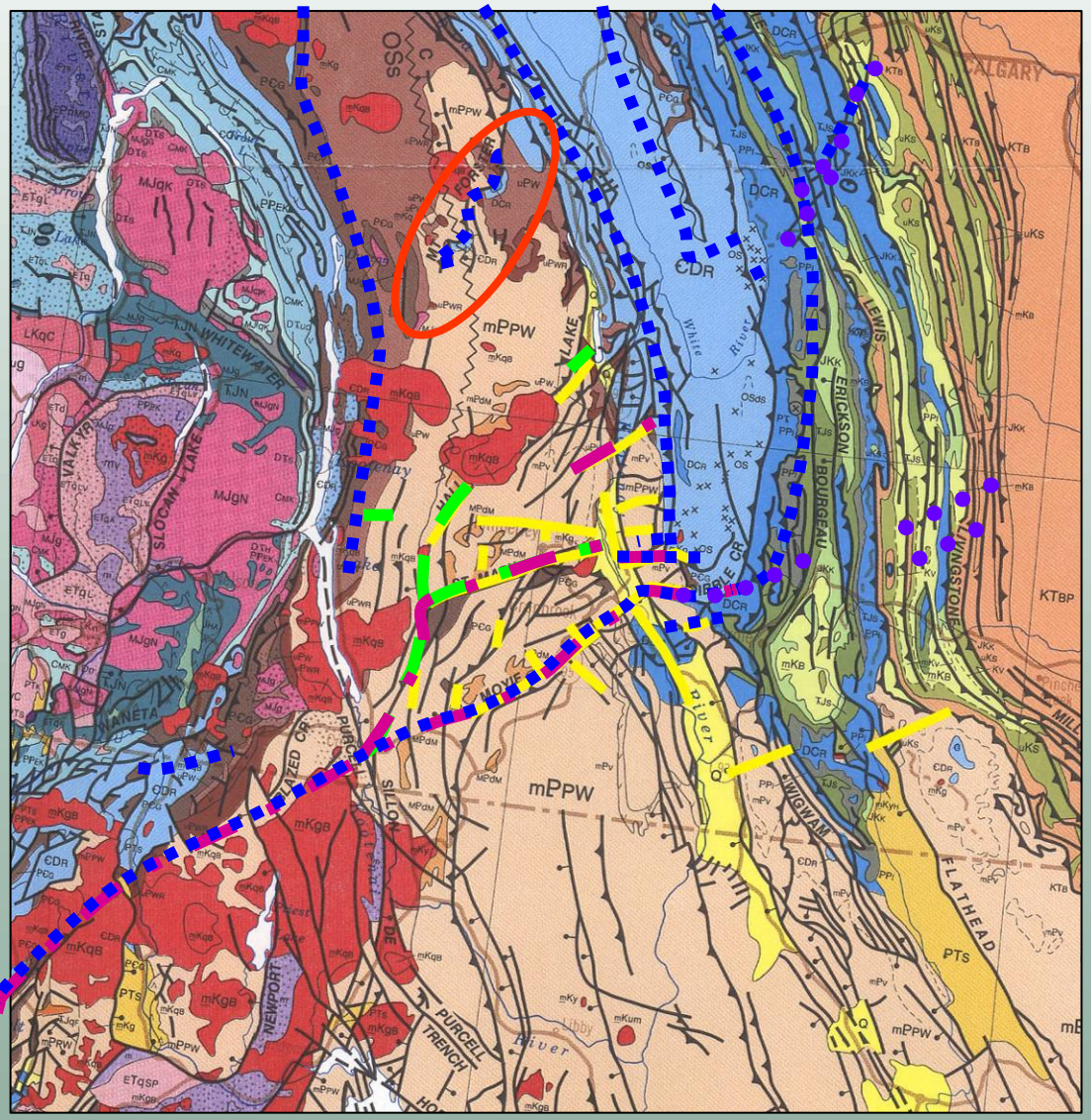
•Exploration along exposed structures has been successful in the past

•Exploration along present traces may be fruitful in the future

-Particularly in preferred mineralization horizons (metallotects) and near structural intersections

•Exploration along buried traces may be fruitful in the future

Basement Structures Provide New Exploration Targets – 1



1. Use Vulcan Low analog exploration toolbox (p. 19) to recognize other transverse basement structures ie
   - Mount Forster fault? (highlighted by ellipse)
2. Examine the palinspastically restored positions of old, mineralization controlling, basement-related structures, to see if basement structure also affected Tertiary intrusion, extension and mineralization
3. Prospect along buried trace of known transverse basement structures

Mesoproterozoic

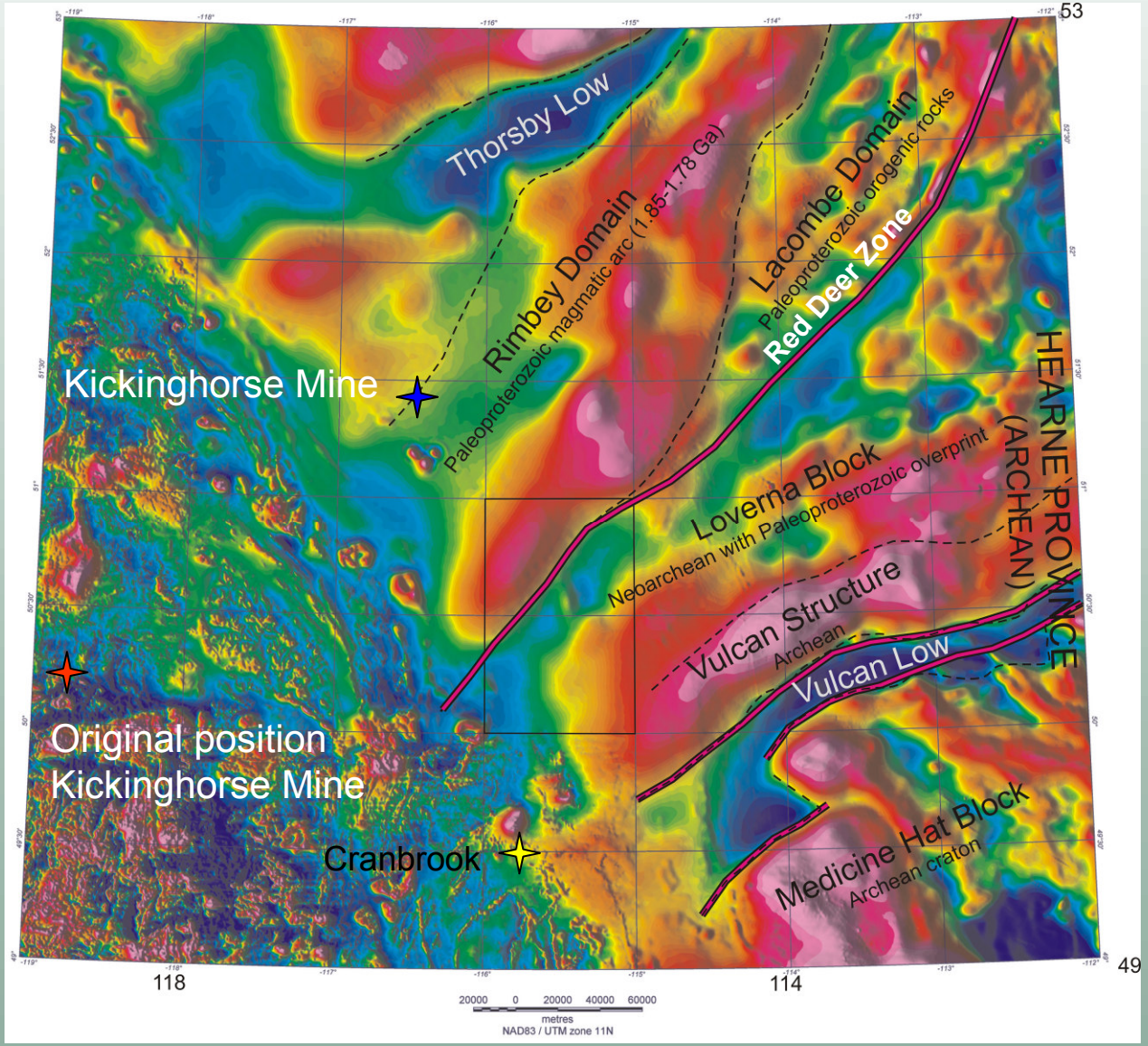
Neoproterozoic

Sub-Cambrian

Lower Paleozoic

Upper Paleozoic

Basement Structures Provide New Exploration Targets – 2



4. Prospect along other first-order basement structures and above their buried extensions to the southwest

Footnotes

1. Open File 5874 is an edited version of a presentation given October 29, 2009 at the Minerals South Conference, Cranbrook, B.C.
2. For details on the stratigraphic changes see Benvenuto and Price (1979), Hoy (1993), McMechan (1981), Price (1981) and references therein.
3. Active structures Neoproterozoic based on Lis and Price (1976), Reesor (1996) and this study.
4. Active structures sub-Cambrian based on Leech (1960), Lis and Price (1976), Price (1981) and references therein.
5. Active structures Lower Paleozoic after Aitken (1993), Cecile and Norford (1993), Grieve (1980), McMechan and Price (1982), Root (2001), Thompson et al.(2006) and references therein.
6. Active structures Upper Paleozoic after Cooley (2007), McMechan (2001), Mott (1989) and this study.
7. Intrusion localities from Wheeler and McFeely (1991) with additional small mid-Cretaceous intrusions from Hoy (1993), BC Minfile 82GSE037, 82G3W010 and R. Hartlaub, pers. comm. 2009. Kimberlite locality from Pell (1994). Age of Hell Roaring Creek stock from (J. Mortenson cited in Anderson and Parrish, (2000)).
8. Mineral deposits in Belt-Purcell modified after Hoy et al. (2009). Gold localities after Holland (1950), Walker (2001) and R.I Thompson (pers. Comm., 2009).
9. Palinspastic restoration of Hall Lake fault involves restoring left-lateral displacement (see Price and Sears, 2000).
10. For Early Tertiary age assignment of Bluebell MTV deposit see Beaudoin et al. (1992) and Moynihan and Pattison (2008).

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References Cited

Aitken, J.D., 1993. Cambrian and Lower Ordovician - Sauk sequence; subchapter 4B; *in* Sedimentary cover of the craton in Canada, (ed.) D.F. Stott and J.D. Aitken; Geological Survey of Canada, Geology of Canada, no. 5, p. 96-124.

Anderson, H.E. and Parrish, R.R., 2000. U-Pb geochronological evidence for the geological history of the Belt-Purcell Supergroup, southeastern British Columbia; *in* The Geological environment of the Sullivan Deposit, British Columbia, (ed.) J.W. Lydon, T. Hoy, J.F. Slack, and M.A. Knapp, Geological Association of Canada, Mineral Deposits Division, Special Publication Number 1, p. 113-126.

Beaudoin, G., Taylor, B.E. and Sangster, D.F., 1992. Silver-lead-zinc veins and crustal hydrology during Eocene extension, southeastern British Columbia, Canada; Geochimica et Cosmochimica Acta, v. 56, p. 3513-3529.

Benvenuto, G.L. and Price, R.A., 1979. Structural evolution of the Hosmer thrust sheet, southeastern British Columbia; Bulletin of Canadian Petroleum Geology, v. 27, p. 360-394.

Bielenstein, H.U., 1969. The Rundle Thrust sheet, Banff, Alberta - a structural analysis; Unpublished Ph.D. thesis, Queen's University, Kingston, Canada, 149 p.

Cecile, M.P. and Norford, B.S., 1993. Ordovician and Silurian strata; subchapter 4C; *in* Sedimentary cover of the craton in Canada, (ed.) D.F. Stott and J.D. Aitken; Geological Survey of Canada, Geology of Canada, no. 5, p. 125-149.

Cooley, M.A., 2007. The structural, thermal, and fluid evolution of the Livingstone Range Anticlinorium, and its regional significance to the southern Alberta foreland thrust and fold belt; Unpublished Ph.D. thesis, Queen's University, Kingston, Canada, 163 p.

Fermor, P.R.,1999. Aspects of the three-dimensional structure of the Alberta Foothills and Front Ranges; Geological Society of America Bulletin, v.111, p.317-346.

Gardner, D.W., 2008. Sedimentology, stratigraphy, and provenance of the Upper Purcell Supergroup, southeastern British Columbia, Canada: Implications for syn-depositional tectonism, basin models, and paleogeographic reconstructions; Unpublished, M.Sc. thesis, University of Victoria, 75 p.

Grieve, D.A., 1981. Diatreme breccias in the Southern Rocky Mountains (82G and J); *in* Geological fieldwork 1980, a summary of field activities; British Columbia Ministry of Energy, Mines and Petroleum Resources, *Geological Fieldwork*, Paper 1981-1, p. 96-103.

Holland, S.S., 1950. Placer gold production of British Columbia; British Columbia Ministry of Energy Mines and Petroleum Resources, Bulletin 28, 89 p.

Hope, J. and Eaton, D.W., 2002. Crustal structure beneath the Western Canada Sedimentary Basin; constraints from gravity and magnetic modeling; Canadian Journal of Earth Sciences, v. 39, p. 291-312.

Hoy, T., 1993. Geology of the Purcell Supergroup in the Fernie west-half map area, southeastern British Columbia; British Columbia Ministry of Energy Mines and Petroleum Resources, Bulletin 84, 157 p.

Hoy, T., Anderson, D., Turner, R.J.W. and Leitch, C.H.B., 2000. Tectonic, magmatic, and metallogenic history of the early synrift phase of the Purcell Basin, southeastern British Columbia; *in* The Geological environment of the Sullivan Deposit, British Columbia, (ed.) J.W. Lydon, T. Hoy, J.F. Slack, and M.A. Knapp, Geological Association of Canada, Mineral Deposits Division, Special Publication Number 1, p. 32-60.

Leech, G.B., 1960. Geology Fernie (west half) Kootenay District, British Columbia; Geological Survey of Canada, Map 11-1960, scale 1:126,720.

Lis, M.G. and Price, R.A., 1976. Large-scale block faulting during deposition of the Windermere Supergroup (Hadrynian) in southeastern British Columbia; Geological Survey of Canada, Paper 1976-1A, p. 135-136.

McMechan, M.E, 1981. Middle Proterozoic Purcell Supergroup, southwestern Rocky and southeastern Purcell Mountains, British Columbia and the initiation of the Cordilleran miogeocline, southern Canada and adjacent United States; Bulletin of Canadian Petroleum Geology, v.29, p. 583-621.

McMechan, M.E., 1995. Geology Rocky Mountain Foothills and Front Ranges in Kananaskis Country, Alberta. Geological Survey of Canada, Map 1865A, scale 1:100,000.

McMechan, M.E., 1998. Geology and structure cross-section, Peter Lougheed Provincial Park, Alberta. Geological Survey of Canada, Map 1920A, scale 1:50,000.

McMechan, M.E., 2001. Large scale duplex structures in the McConnell thrust sheet, Rocky Mountains, southwest Alberta; Bulletin of Canadian Petroleum Geology, v. 49, p. 408-425.

McMechan, M.E. and Leech, G.B., 2010a. Geology, Kananaskis Lakes, British Columbia–Alberta; Geological Survey of Canada, Open File 5801, scale 1:50 000.

McMechan, M.E. and Leech, G.B., 2010b. Geology, Mount Assiniboine, British Columbia–Alberta; Geological Survey of Canada, Open File 6182, scale 1:50 000.

McMechan, M.E. and Mott, J.A., 2010. Geology, Mount Abruzzi, British Columbia; Geological Survey of Canada, Open File 6404, scale 1:50 000.

McMechan, M.E. and Price, R.A., 1982. Transverse folding and superposed deformation, Mount Fisher area southern Canadian Rocky Mountain thrust and fold belt; Canadian Journal of Earth Sciences, v. 19, p. 1011-1024.

Mott, J.A., 1989. Structural and stratigraphic relations in the White River region, eastern Main Ranges, southern Rocky Mountains, British Columbia; Unpublished Ph.D. thesis, Queen's University, Kingston, Canada, 404 p.

Moynihan, D.P. and Pattison, D.R.M., 2008. Origin of the Kootenay Lake Metamorphic High, south-eastern British Columbia; in Geological Fieldwork, 2007, British Columbia Ministry of Energy, Mines and Petroleum Resources Paper 2008-1, p. 147-158.

Pell, J., 1994. Carbonatites, nepheline syenites, kimberlites and related rocks in British Columbia; British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Survey Branch, Bulletin, No. 88, 136 p.

Price, R.A., 1981. The Cordilleran thrust and fold belt in the southern Canadian Rocky Mountains; *in* Thrust and nappe tectonics, (ed.) K.R. McClay and N.J. Price, Geological Society of London Special Publication 9, p. 427–448.

Price, R.A. and Fermor, P.R., 1985. Structure section of the Cordilleran Foreland Thrust and Fold Belt west of Calgary, Alberta. Geological Survey of Canada, Paper 84-14, 1 sheet.

Price, R.A. and Lis, M.G., 1975. Recurrent displacements on basement-controlled faults across the Cordilleran Miogeocline in southern Canada; *Geological Society of America, Abstracts with Programs v.* 7, no. 7, p. 1234.

Price, R.A. and Sears, J.W., 2000. A preliminary palinspastic map of the Mesoproterozoic Belt-Purcell Supergroup, Canada and USA: Implications for the tectonic setting and structural evolution of the Purcell Anticlinorium and the Sullivan deposit; *in* The Geological environment of the Sullivan Deposit, British Columbia, (ed.) J.W. Lydon, T. Hoy, J.F. Slack, and M.A. Knapp, Geological Association of Canada, Mineral Deposits Division, Special Publication Number 1, p. 61-81.

Reesor, J.E. (comp.), 1996. Geology, Kootenay lake, British Columbia, Geological Survey of Canada, Map 1864A, scale 1:100,000.

Root, K.G., 1987. Geology of the Delphine Creek area, southeastern British Columbia: implications for the Proterozoic and Paleozoic development of the Cordilleran Divergent Margin; Unpublished Ph.D. thesis, University of Calgary, Calgary, Alberta, 446 p.

Root, K.G., 2001. Devonian Antler fold and thrust belt and foreland basin development in the southern Canadian Cordillera: implications for the Western Canada Sedimentary Basin; Bulletin of Canadian Petroleum Geology, v. 49, p. 7-36.

Sanderson, D.A., 1998. Transverse fault geometries and their possible origins in the Rundle and Lewis thrust sheets in the Highwood Pass area, Alberta Front Ranges; Program with abstracts, Geological Association of Canada, Mineralogical Association of Canada, Joint Annual Meeting, v. 23, p. 164.

Thompson, R.I., Glombick, P., Erdmer, P., Heaman, L.M., Lemieux, Y. and Daughtry, K.L., 2006. Evolution of the ancestral Pacific margin, southern Canadian Cordillera: Insights from new geologic maps; *in* Paleozoic evolution and metallogeny of the pericratonic terranes at the Ancient Pacific margin of North America, Canadian and Alaskan Cordillera; (ed.) M. Colpron and J.L. Nelson, Geological Association of Canada, Special Publication Number 45, p. 433-482.

Walker, R.T., 2001. Assessment report for the Findlay Creek area claims, Fort Steele Mining Division; British Columbia Geological Survey Branch Assessment Report 26,779, 56 p.

Wheeler, J.O., and McFeely, P., 1991. Tectonic assemblage map of the Canadian Cordillera and adjacent parts of the United States of America: Geological Survey of Canada, Map 1712A, scale 1:2,000,000.