Journal of Structural Geology 68 (2014) 273–299

Contents lists available at ScienceDirect

Journal of Structural Geology

journal homepage: www.elsevier.com/locate/jsg

Kinematics and timing of shear zone deformation in the western Coast Belt: evidence for mid-Cretaceous orogen-parallel extension

Joel J. Angen [a,*], Cees R. Van Staal [a,b], Shoufa Lin [a], JoAnne L. Nelson [c], J. Brian Mahoney [d], Donald W. Davis [e], William C. McClelland [f]

[a] Department of Earth and Environmental Sciences, University of Waterloo, 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada
[b] Geological Survey of Canada, 625 Robson Street, Vancouver, BC V6B 5J3, Canada
[c] British Columbia Geological Survey, 1810 Blanshard Street, Victoria, British Columbia V8W 9N3, Canada
[d] Department of Geology, Philips Science Hall 157, University of Wisconsin-Eau Claire, Eau Claire, WI 54702-4004, USA
[e] Department of Earth Sciences, University of Toronto, 22 Russell St., Toronto, Ontario M5S 3B1, Canada
[f] Department of Earth and Environmental Sciences, 121 Trowbridge Hall, University of Iowa, Iowa City, IA 52242, USA

A R T I C L E I N F O

Article history:
Available online 18 June 2014

Keywords:
Cordillera
Transpression
Mid-Cretaceous
Conjugate
High-strain zone
Coast Belt

A B S T R A C T

Northwest-striking sinistral shear zones characterize mid-Cretaceous deformation in the western Coast Belt south of Prince Rupert in north coastal British Columbia. Structurally focused mapping and geochronology have revealed a component of lateral extension to this deformation. General flow characteristics of the shear zones are identified by comparison of fabric patterns to published models for fabric development in shear zones. U–Pb ages from synkinematic dykes constrain motion on northwest-striking sinistral transpressional shear zones, including the Useless, Barrett and Salt Lagoon shear zones, to ca. 104–96 Ma, and dextral transpression on the north-striking Telegraph Passage shear zone to ca. 97 Ma. The geometry, kinematics, and coeval nature of these shear zones suggest that they formed in part as a ductile conjugate set. The orientation of these conjugate sets indicates ENE–WSW (orogen perpendicular) shortening and NNW–ESE (orogen parallel) extension. The conjugate shear zones merge together into the Grenville Channel shear zone, a sinistral transpressional shear zone with high strike-parallel stretch indicating the same strain field. This local strain regime is consistent with large-scale mid-Cretaceous tectonic escape as proposed for the northern Cordillera at that time, expressed in coeval sinistral faulting in the Coast Belt and dextral faulting in the northern Omineca belt.

1. Introduction

The North American Cordillera is the type example of a complex accretionary orogen (Condie, 2007). It has been active as a convergent margin since the Devonian, undergoing periods of contraction, extension, terrane accretion, and strike-slip shearing. The terranes of the northern Cordillera have been grouped into five lithotectonic entities on the basis of stratigraphic, intrusive, isotopic, and faunal connections (Colpron et al., 2007; Fig. 1). The easternmost of these is ancestral North America, which includes the Laurentian craton, marginal sedimentary rocks, and associated parautochthonous terranes. The core of the northern Cordillera is occupied by the Intermontane terranes which evolved as a series of island arcs built on pericratonic fragments that rifted away from western North America during the Devonian (Colpron et al., 2006; Nelson et al., 2006). Outboard of the Intermontane terranes are the Insular and Northern Alaskan terranes which appear to have evolved in close proximity to Baltica, Siberia, and possibly Arctic Laurentia during the Neoproterozoic to mid Paleozoic (Colpron and Nelson, 2009; 2011a; Beranek et al., 2012). Mesozoic and younger arc and accretionary complexes fringe the western margin of the northern Cordillera. Oceanic and accretionary complexes (in red on Fig. 1) provide a record of ocean basins that have closed during evolution of the northern Cordillera. Two metaplutonic 'welts' overprint the terranes outlined above (Monger et al., 1982). They include the Omineca Belt, which roughly corresponds to the Intermontane-ancestral North America boundary, and the Coast Belt along the Insular-Intermontane boundary (Fig. 1). They have historically been attributed to arc magmatism, terrane accretion, or a combination of the two (Monger et al., 1972; Monger et al., 1982; van der Heyden, 1992; McClelland et al., 1992).

* Corresponding author. Tel.: +1 250 895 1486.
E-mail address: angenjoel@gmail.com (J.J. Angen).

http://dx.doi.org/10.1016/j.jsg.2014.05.026
0191-8141/

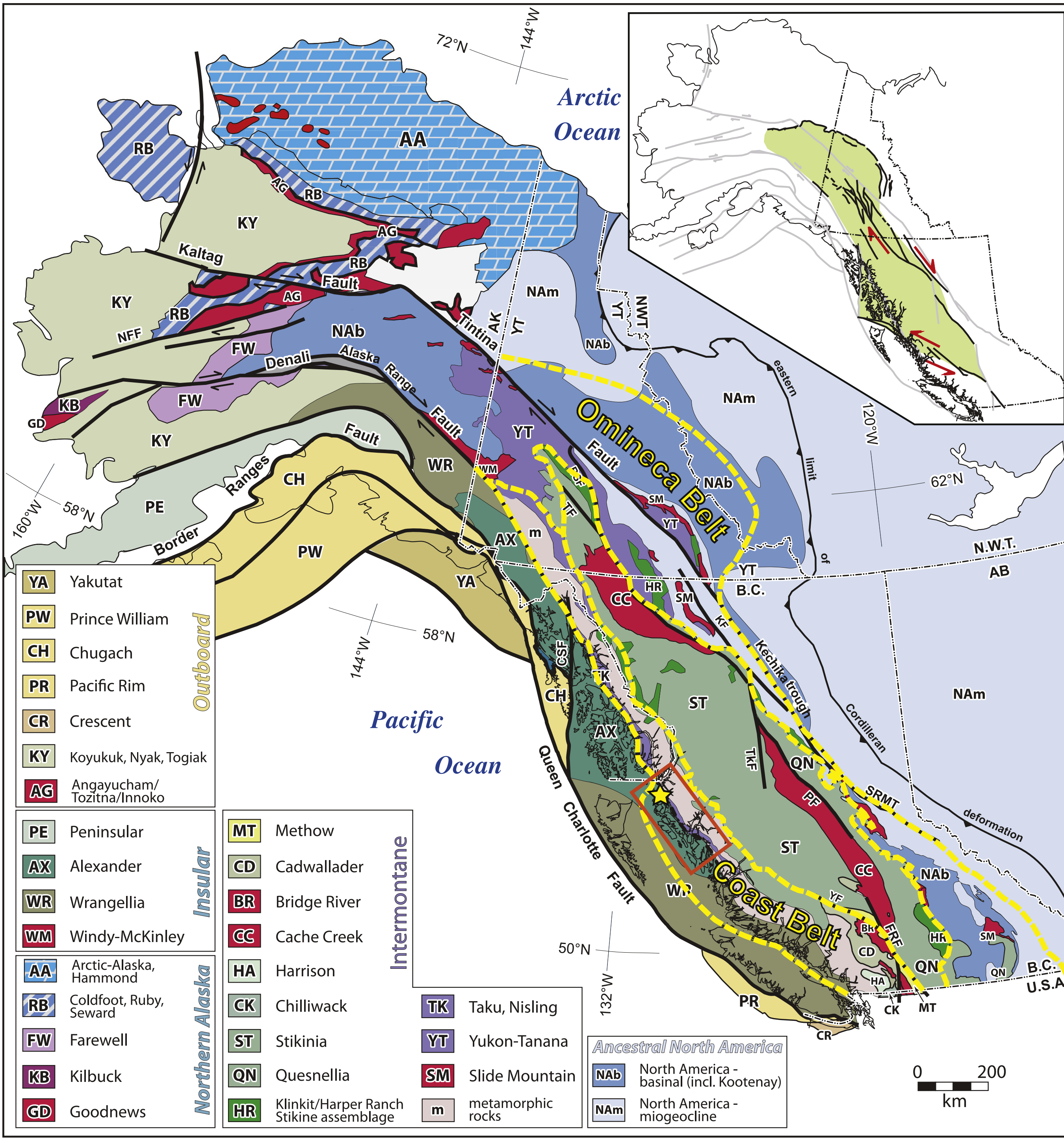

Fig. 1. Terrane map of the northern Cordillera and location of the metaplutonic 'welts' outlined in yellow. The location of Fig. 2 is represented by the orange outline and Prince Rupert is represented by the yellow star (modified after Colpron et al., 2007; Colpron and Nelson, 2011b; Wheeler and McFeely, 1991). Inset map includes major mid-Cretaceous structures through the northern Cordillera which are dominantly sinistral in the Coast Belt and dextral in the Omineca belt, outlining an escape block comprised of the Intermontane terranes (modified after Colpron et al., 2011a). Note that 450 km of younger dextral displacement across the Tintina fault has been removed in inset map. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The mid-Cretaceous was a time of active deformation, magmatism, and metamorphism in the northern Cordillera in British Columbia, Yukon, and Alaska, as well as northern Washington state. Observations along the Coast Belt indicate sinistral transpression (Roddick, 1970; Lawrence, 1978; Rusmore, 1985; Miller, 1988; Leitch et al., 1989; Schiarizza et al., 1990; Woodsworth et al., 1991; Greig, 1992; Greig et al., 1992; Hurlow, 1993; Schiarizza et al., 1997; Chardon et al., 1999; Israel, 2001; Israel et al., 2006; Demerse, 2008; Israel, 2008; Mahoney et al., 2009; Nelson et al., 2010a, 2011a, 2012), whereas observations within the Omineca Belt indicate dextral transpression (Gabrielse, 1969, 1985; Abbott and Turner 1991; Mortensen and Hansen 1992; Murphy, 1997; Gabrielse, 1998; Colpron, 2006; Gabrielse et al., 2006; Mortensen et al., 2006). These observations led to the proposal that the