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Paleogeography of the North American Cordillera:
Evidence For and Against Large-Scale Displacements

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REVIEWS

Paleogeography of the North American Cordillera: Evidence For and Against Large-Scale Displacements

Edited by J.W. Haggart, R.J. Enkin and J.W.H. Monger
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The story of this book began to unfold for me in 1973, in casual talk with a young woman who was working in the geology library at the University of British Columbia. She had just finished her graduate degree; I was just starting mine. Studious and understated, she seemed an unlikely instrument of upheaval in Cordilleran tectonic thinking. And yet she was exactly that. Her name was Linda Noson, and she, along with her advisor, Myrl Beck, had just published a highly discordant paleopole from the Cretaceous Mt. Stuart batholith in the North Cascades (see Beck and Noson 1972), that called for some 3000 kilometres of northward motion for the western Cordillera since then – a solid-earth equivalent of the speed of light.

That was in the early, heady days of plate tectonic analysis of the Cordillera, when the Mt. Stuart pole was just one of six impossible things before breakfast, along with news of exotic, Asian faunas near Cache Creek in the BC interior; Franciscan-type blueschist belts embedded deep in the central Cordillera near Fort St. James; and recognition of major dextral slip on the Tintina fault that could kinematically link it, like the San Andreas in Tanya Atwater's seminal 1970 model, to rapid northward motion of offshore oceanic plates. "*Eppur si mouve*" was the word of the day, and all lines of evidence, like the propitious stars, seemed to be lining up.

Through the 1980s and 1990s, studies of greater depth and precision in all fields flooded in, adding detail and, as it turned out, adding devils. In particular, a rift formed and then widened between paleomagnetic pole determinations on one hand, and mapped geological relationships and latitudinal interpretations of paleontology on the other, concerning what did or did not happen in the Canadian Cordilleran orogen as it reached a mature stage of its development in Late Cretaceous time. Ted Irving, working at the Pacific Geoscience Centre, completed paleomagnetic studies on a number of Cretaceous intrusions that, like the results of Myrl Beck and his students, showed anomalously shallow inclinations compared to North American cratonal poles. Rejecting tilting in favour of large-scale northward translation, he coined the now-famous "Baja BC" moniker (Irving 1985). But as time went on, a third word has barnacled itself onto Irving's invention, namely "controversy". It was a problem inherent in the data refinement process: clearly things have moved, but which pieces, by how much, and when? The bedrock mappers took issue with the stipulated magnitudes and timing of displacement. The debate intensified and attracted new proponents: bold sallies by Mark Brandon and Paul Umhoefer advocating Cretaceous northward transport of the western Canadian Cordillera from southern California/northern Mexico met lively ripostes by Bob Butler, George Gehrels and Ken Kodama, who deconstructed the all-translation option in favour of a combination of translation, tilt and compaction, to better mesh with observed geological relationships. By the 20th century's end, the Baja BC controversy had joined Pangea B as one of the two great paleomagnetic/geologic debates of our time.

Enter this excellent volume, Paleogeography of the North American Cordillera: Evidence For and Against Large-Scale Displacements, based on a GAC Special Session in 2003, and published in 2006 under the editorship of Jim Haggart, Randy Enkin and Jim Monger. Here you will not find easy resolution. On the contrary, a careful reading of the key papers in it will show how the lines of evidence on each side, like opposing chess pieces, draw into ever closer and more belligerent arrays. Randy Enkin, in his fine synoptic paper, offers the best and most careful analysis yet of all existing Cretaceous paleopoles. He emphasises the most reliable of them, especially those from bedded rocks, and shows that overall the Cordilleran poles cluster well at about 15^{O} paleolatitude south of poles from contemporary North America, implying 2100 ± 700 kilometres of northward translation compared to the Eocene set, which are concordant. Most provocative is a new determination from 70 million year old basalts on Solitary Mountain, which is presented in a separate paper here by Enkin and

colleagues. This little peak is located near the eastern edge of the Cordilleran allochthons in central Yukon, separated from strata of the North American shelf and slope by two major faults, the Tummel and the Tintina. The Solitary Mountain pole coincides with the Cordilleran cluster, indicating about 2000 kilometres of northward transport between 70 and 50 million years ago.

One is hard pressed, however, to find support for this magnitude of displacement on the known faults. The paper by Gabrielse and colleagues presents multiple, carefully documented constraints on Tintina displacement that show 490 kilometres of dextral motion across it overall, with 430 kilometres during the Eocene when, paleomagnetically, the Baja BC train was already in the station. And evidence of mid-Cretaceous thermal overprinting across the Tummel fault, presented in the Gladwin and Johnston paper, effectively eliminates it as a candidate for end-Cretaceous motion of any significance.

These four papers (Enkin; Enkin et al.; Gabrielse et al.; Gladwin and Johnston) lay out the conflict in more precise terms than ever before. Instead of paleomagnetically-indicated translations ranging from 1500 to 3500 kilometres, involving rocks of the tectonically messy western Cordillera, we now have Solitary Mountain versus the Tintina fault: 2100±700 kilometres versus 400–490 kilometres: too little, too late. This puts our collective feet to the fire. It urges us to put the question to both paleomagnetic and geologic datasets, along the lines suggested some years ago by Cowan et al. (1997) as well as Butler et al. (2001). Make no mistake, though: the ground has shifted. Instead of the almost inscrutable lands of the western orogen, we are now poking among braided thrust faults, telescoped facies boundaries and sedately sprawled Early Cretaceous plutonic suites in the northern miogeocline in pursuit of either a cryptic great fault, or 2000 kilometres worth of distributed dextral smearing, or both.

In a separate section of the volume, the paleontologists weigh in. Papers by Paul Smith on Early Jurassic molluscs, Claudia Schröder-Adams and Jim Haggart on Jurassic foraminifera, Elizabeth Carter and Jim Haggart on Jurassic and Cretaceous radiolaria, and Justine Pearson and Richard Hebda on leaf morphotypes are all consistent with northerly late Mesozoic paleolatitudes for the outboard insular terrane, in opposition to the paleomagnetically-indicated more southerly option.

The Baja BC debate, then, continues on, and continues to bring with it all of the benefits that a good scientific controversy can offer. It makes us sharpen our tools and develop new ones. Like an unsolved mystery, it stimulates the detective in us all. This impulse is seen in some of the more speculative papers in the geology section of the book, that lay out the joys of imaginative tectonic reconstructions, not all of them to do with Baja BC *per se*. Umhoefer and Blakey propose possible southern locations of the pre-Cretaceous Canadian Cordillera; Monger and Struik posit a large-scale sinistral offset to account for relationships in the North Cascades; Anderson and Mahoney revisit the Mojave–Sonora megashear; and Wright and Wyld offer an innovative model for the origin of some Cordilleran terranes via a Caribbean-style arc that scooted out of Iapetus in the late Paleozoic.

Finally, in the field of Paleozoic paleogeographic reconstructions, a time when all agree that most terranes were extremely mobile and the only question is where in the vast reaches of Panthalassa did they reside, there is some good and useful new paleontologic fodder in the Pedder and the Gunning and Belasky contributions.

I have two fairly minor criticisms of this volume. The first has to do with its organization, which is subdivided along the prosaic subject headings of "geology", "paleomagnetism", "paleontology" and "paleoclimate". I would prefer to see all of the papers relevant to Cretaceous (*aka* Baja BC) matters grouped together, as they naturally form a set. The second is that, although there is an introduction that summarizes the content of each paper, the editors have left us with no final words of guidance on where we should take this business next.

But all in all, this volume is full of fascinating stuff. It would form a wonderful basis for a seminar course, because it illustrates so well both the diversity of geoscience data brought to bear on a common problem, and the role of different intellectual styles in shaping approaches and interpretations. In reading through it, you are there with the authors; you join the scrum and scramble that goes on just outside a newly-forming face on the otherwise well-ordered crystal of our knowledge.

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