

Late Cretaceous paleogeography of Wrangellia: Paleomagnetism of the McColl Ridge Formation, southern Alaska, revisited: Comment

COMMENT

Ian Mynatt
Bernard A. Housen
Myrl E. Beck Jr.

Geology Department, Western Washington University, Bellingham, Washington 98225, USA

Introduction. Stamatakos et al. (2001) revisited the paleomagnetism of the MacColl Ridge Formation in Alaska, finding smaller northerly transport than a prior study, concluding that their result is incompatible with studies supporting large-scale transport of Coast-Cascade Belt terranes along the craton from 85 to 55 Ma.

One of these incompatible studies is of Mt. Tatlow, British Columbia (Wynne et al., 1995). Wynne et al.'s result indicated 3000 ± 500 km of northward displacement of the eastern Coast Belt relative to North America since 88 Ma. The purpose of this comment is to examine the Wynne et al. (1995) study in light of this criticism.

Overview of the Mt. Tatlow study. The Mt. Tatlow syncline has upper strata of the Powell Creek volcanics (79 Ma) and lower strata of the Silverquick conglomerate (92 Ma). Diorite intrusions (69 Ma) are present and cut both sequences. The Silverquick in the study area is mostly planar-laminated overbank deposits of siltstone and mudstone. The Powell Creek volcanics are subaerial andesitic to basaltic flows, with fluvial interbeds.

The geology of the area is very appropriate for a paleomagnetic study. The crux of any paleomagnetic study is establishing the relationship between the magnetic field and paleohorizontal. The well-defined strata provide precise paleohorizontal orientations for both overbank deposits and lavas. Comparing inclinations in the lavas and sedimentary rocks also rules out compaction shallowing of the inclination in the sediments.

Wynne et al. (1995) found two sets of directions, one with low thermal unblocking temperatures (T_{UB}), and one with high (575 °C) T_{UB} . Sites with high T_{UB} pass a fold test with maximum precision (k) at 100% untilting, so this direction is pre-folding. Low- T_{UB} sites have maximum precision at 30% untilting. The low- T_{UB} , syn-folding directions came from rocks that were altered and match directions from the younger diorites. This secondary magnetization was not used by Wynne et al. (1995) to establish the paleolatitude of Mt. Tatlow.

Reliability criteria. Paleomagnetic reliability criteria, such as the seven criteria of Van der Voo (1989), present a way to differentiate between reliable and possibly suspect data.

The Mt. Tatlow study satisfies six of the criteria. The rocks are well dated. The quantity of samples (437 specimens, 32 sites) is sufficient. Stepwise demagnetization was done. Field tests are satisfied by the use of fold tests. Bedding in both the volcanics and sediments supplies paleohorizontal. The magnetization occurred during the Cretaceous long normal, so the sixth criterion is not met. Finally, the 100% tilt corrected directions are distinct from both younger (expected) directions, and from the low- T_{UB} and diorite directions, so remagnetization is not suspected on this basis.

Based on meeting six of seven Van der Voo criteria the Mt. Tatlow study is reliable. Stamatakos et al.'s (2001) study also satisfies six of seven criteria. Both represent highly reliable studies according to currently accepted standards.

Mt. Tatlow criticisms. Stamatakos et al. (2001, p. 950) cite Butler et al. (1989, 1997) to suggest that the Mt. Tatlow study is unreliable as "accurate structural corrections cannot be unequivocally estab-

lished," but do not explain why this is so. Examination of these papers reveals no mention of Mt. Tatlow. The clear paleohorizontal indicators at Mt. Tatlow refute this argument.

Butler et al. (2001, p. 6–7) do examine the Mt. Tatlow result. They argue that because some rocks have evidence of secondary magnetite and "maximum clustering of paleomagnetic directions occur at 70% unfolding" the structural data and final directions are problematic, as cited by Stamatakos et al. (2001). These arguments ignore the fact that the high- T_{UB} direction has maximum clustering at 100% unfolding, and is distinct from the syn-folding directions.

Discussion. When two findings are contradictory, the first step is to examine them using established reliability criteria. Both of these studies are reliable by any objective measure. Next, other explanations should be pursued instead of needlessly discrediting the results.

Are the paleolatitudes obtained really incompatible? Stamatakos et al. (2001) found 1650 ± 900 km of northward displacement for Wrangellia since 80 Ma. Wynne et al. (1995) found 3000 ± 500 km of northward displacement for Mt. Tatlow since 88 Ma. (Note: 88 Ma, not 98–74 Ma as given by Stamatakos et al. [2001], is the most appropriate magnetization date for Mt. Tatlow, because rocks younger than 84 Ma were not used in the final result.) The 8 m.y. difference between the magnetization age of these two units, using a transport rate of 10 cm/yr, reduces the transport anomaly by 800 km. Accordingly, Mt. Tatlow would be at 43°N at 80 Ma. The resulting 10° (or 1110 km) difference in the 80 Ma paleolatitudes of Mt. Tatlow and the McColl Ridge rocks does not seem incompatible given the current difference of 10° of latitude between the two locations today.

If the ages of magnetization of the two units were identical, the results would require the two units to be on separate terranes, with 700–1100 km of post-80 Ma displacement relative to each other. Given the reliability of the two studies this is a more realistic conclusion than that bedding at Mt. Tatlow was erroneously measured. We suggest that these possibilities do better justice to the reliable paleomagnetic studies of Stamatakos et al. (2001) and Wynne et al. (1995). We conclude that criticisms of the Wynne et al. (1995) study by Stamatakos et al. (2001) are entirely unsubstantiated. The results of these two studies are in fact mutually inclusive, providing additional evidence for large-scale displacement of Cordilleran terranes during the late Cretaceous.

ACKNOWLEDGMENTS

We thank Ted Irving for his contributions to our comment, most importantly his suggestion that the first author's term paper be modified and submitted here.

REFERENCES CITED

- Butler, R., Gehrels, G., McClelland, W., May, S., and Klepacki, D., 1989, Discordant paleomagnetic poles from the Canadian Coast Plutonic Complex: Regional tilt rather than large scale displacement? *Geology*, v. 17, p. 691–694.
- Butler, R., Gehrels, G., and Bazard, D., 1997, Paleomagnetism of Paleozoic strata of the Alexander terrane, southeastern Alaska: *Geological Society of America Bulletin*, v. 109, p. 1372–1388.
- Butler, R.F., Gehrels, G.E., and Kodama, K.P., 2001, A moderate translation alternative to the Baja British Columbia hypothesis: *GSA Today*, v. 11, no. 6, p. 4–10.
- Stamatakos, J.A., Trop, J.M., and Ridgway, K.D., 2001, Late Cretaceous paleogeography of Wrangellia: Paleomagnetism of the MacColl Ridge Formation, southern Alaska, revisited: *Geology*, v. 29, p. 947–950.
- Van der Voo, R., 1989, Paleomagnetism of North America: The craton, its margins, and the Appalachian Belt, in Pakiser, L.C., and Mooney, W.D., eds., *Geophysical framework of the continental United States*: Geological Society of America Memoir 172, p. 447–470.
- Wynne, P.J., Irving, E., Maxson, J., and Kleinspehn, K., 1995, Paleomagnetism of the Upper Cretaceous strata of Mount Tatlow: Evidence for 3000 km of northward displacement of the eastern Coast Belt, British Columbia: *Journal of Geophysical Research*, v. 100, p. 6073–6092.