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LETTER TO THE EDITOR

Comment on: "Latest Pleistocene Increase in Wind Intensity Recorded in Eolian Sediments from Central Alaska," by N. Bigelow, J. E. Begét, and W. R. Powers

INTRODUCTION

In their recent paper on eolian sediments from interior Alaska, Bigelow *et al.* (1990) ascribe changes in eolian sediment particle size to a climatic change associated with the Younger Dryas cold oscillation. Although we applaud the authors' attempt to cast the eolian record from central Alaska in a global context, we disagree with their portrayal of the physical characteristics of the local and regional stratigraphic records, and more importantly, with their interpretation of the climatic significance of grain-size changes in the eolian deposits they discuss. Furthermore, we believe that the authors have overestimated the accuracy of age control on the sedimentary record, their basis for correlating eolian deposits to the Younger Dryas interval.

The Younger Dryas event was a brief and dramatic climatic reversal during the Pleistocene–Holocene transition (ca. 11,000–10,000 yr B.P.) that is well-documented in a variety of proxy records of paleoclimate from the North Atlantic region (e.g., Wright, 1989). The geographic extent of climatic change during the Younger Dryas interval beyond the North Atlantic region must be known so that plausible mechanisms for the climatic oscillation can be developed. In this regard, paleoclimate records that display oscillations are as important as those that show no oscillations. Thus, the paleoclimatologist must be especially rigorous in evaluating the full suite of available data to determine the nature and timing of climatic change during the Pleistocene–Holocene transition. The purpose of this letter is to comment on the interpretation of eolian "sand layers" and other proxy data as evidence of a climatic oscillation in interior Alaska during the Younger Dryas interval.

Regional Distribution of "Sand Layers"

Bigelow *et al.* (1990) portray the sedimentary profiles in the Nenana Valley as containing "systematic patterns of grain-size changes," although they provide data at only two exposures, Dry Creek and Walker Road. Previous study of more than 30 stratigraphic sections in the Nenana Valley indicates no regularity to the terrace-top eolian stratigraphy (Wahrhaftig, 1958; Thorson and Hamilton, 1977; Hoffecker, 1985, 1988; Waythomas, 1989). Eolian sequences from the region typically exhibit a wide range of thickness, texture, buried-soil content, and age relations, and lack any obvious stratigraphic pattern in either north–south or east–west directions (Hoffecker, 1985, 1988; Hoffecker *et al.*, 1988). The stratigraphy at some localities, including Walker Road and Dry Creek, is further complicated by multiple, small-scale thrust faults that severely deform the eolian sediments (Thorson and Hamilton, 1977; Waythomas, 1989). The lateral and vertical variability in the eolian sedimentary sequences indicates that grain-size changes could be related to site-specific factors rather than climatic change.

Interpretation of "Sand Layers"

Bigelow *et al.* (1990) contend that variations in grain size from medium-to-fine sand to silt indicate "significant environmental change," and that sharp contacts

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between stratigraphic units "suggest that environmental changes occurred rapidly." Although discontinuities in eolian deposits may be attributable to environmental changes, other interpretations are equally plausible. Modern-process studies (Hunter, 1977; McKee, 1979; Fryberger and Schenk, 1981, 1988; Brookfield and Ahlbrandt, 1983; Kocurek and Nielson, 1986), as well as studies of late-Quaternary eolian sediments (Fryberger *et al.*, 1979; Koster, 1988; Koster and Dijkmans, 1988; Lea, 1990), have demonstrated that small-scale textural variations may be caused by single extreme events (i.e., wind storms lasting hours to days rather than years to centuries), being in part manifestations of *weather*, not climate. Textural variability in the eolian deposits could reflect the dynamic interaction of other components of the eolian system that are unrelated to climate. The occurrence and textural characteristics of eolian sediment profiles in the Nenana Valley may indicate proximity to sediment sources, such as alluvial fans, landslide scarps, or unvegetated bluff faces formed by indigenous river processes (lateral plantation, incision). Other natural processes, such as forest and tundra fires, also could initiate episodes of eolian deflation and sedimentation.

At the Walker Road and Dry Creek sites, the authors describe a "sand layer" (S1) intercalated between loess that they suggest represents a "jump in wind intensity." (Note, however, that their single particle-size analysis shows that the so-called "sand layer" actually consists of 70% silt- and clay-sized particles at Walker Road (correctly classified as a silty loam, USDA, Soil Survey Staff, 1975), whereas sediment of the same textural composition at Dry Creek was termed "loess"). Unit S1 is one of four "sand layers" identified at both sites. Sand-bearing eolian deposits dominate the upper third of the sections, yet the authors do not ascribe climatic significance to the upper "sand layers" despite their apparent similarity to S1. If the overall coarsening upward trend shown by the Walker Road and Dry Creek sections is interpreted strictly in terms of climatic change (as the authors suggest), the increase in sand layers implies that wind speeds in Alaska have been intermittently as strong as those of the Younger Dryas for much of the last 5000 years. The up-section increase in sand content demonstrates that a global, "Younger Dryas type" climatic oscillation is not required to explain the eolian record and points to an alternative explanation. Rather than a "jump in wind intensity," we suggest that variations in particle size may reflect the availability of source sediment, namely the proximity to unvegetated bluffs formed by downcutting or laterally shifting rivers.

Interestingly, Bigelow *et al.* (1990) did not include data on mass susceptibility of the sedimentary profiles, despite the recent arguments of one of the authors that mass-susceptibility changes recorded in loess of central Alaska are related to fluctuations in wind intensity, both of which increased during past glacial episodes (Begét *et al.*, 1990; Begét and Hawkins, 1989). Thus, an important test of the climatic significance of "sand layer" S1 at Walker Road and Dry Creek would seem to be lie in mass-susceptibility measurements. However, measurements made by one of us (Waythomas, 1989, and unpublished data) at both sites demonstrate that the mass susceptibility of the unit termed S1 by Bigelow *et al.* (1990) is lower (mass-susceptibility values of 0.15 to 0.5 $\times 10^{-6}$ m^3/kg) than the mass susceptibility of buried soils (mass-susceptibility values of 1.4 to 6.5 $\times 10^{-6}$ m^3/kg) in each section. Thus, based on its low mass susceptibility, the climatic significance applied to S1 by Bigelow *et al.* (1990) directly contradicts the interpretation of Begét *et al.* (1990).

Chronology

The assertion of Bigelow *et al.* (1990) that unit S1 provides a record of increased wind intensity during the Younger Dryas interval hinges not only on their interpretation of the physical stratigraphy, but also on the precision and accuracy of their chronological control. The authors claim that "the episode of increased wind intensity . . . occurred from ca. 11,100 to 10,700 yr B.P." (p. 167). The maximum age of "sand layer" S1 at Walker Road is indeed well-constrained at ca. 11,100 yr B.P. by AMS ^{14}C dating of charcoal (note, however, that two of the four dates shown by Bigelow *et al.* (1990, Fig. 2) for the unit underlying S1 are misplotted). However, the reported minimum age for S1 is based entirely on a single conventional ^{14}C determination on charcoal in loess overlying a supposed correlative sand layer at Dry Creek. The minimum age of 10,700 ± 250 yr B.P. is one of a suite of 11 dates that range from 6270 ± 110 to 23,930 ± 9300 yr B.P., all on charcoal collected from the overlying 70 cm. The wide range and mixed stratigraphic order of ^{14}C dates led Thorson and Hamilton (1977, p. 166–167) in their original work on the Dry Creek site to conclude that the charcoal samples were contaminated by fine particles of coal or lignite from nearby pre-Pleistocene coal-bearing strata. Given the demonstrated potential for contamination by old carbon, it is unclear how Bigelow *et al.* (1990) could select a single determination from a number of clearly unreliable dates to constrain the minimum age of S1. Even more unsettling is the statement that "the radiocarbon dates suggest that layer S1 formed during an interval lasting approximately 400 yr" (p. 161), when the bracketing dates are not statistically different at $\pm 2\sigma$.

Other radiocarbon dates from the Panguingue Creek and Owl Ridge sites are used by Bigelow *et al.* (1990) to constrain the age of "sand layers" that are correlated with S1. Although a date of 10,180 ± 180 yr B.P. (AA-1686) from the Panguingue Creek site is within the Younger Dryas interval, another date of 8170 ± 120 yr B.P. (AA-1687; Hoffecker, 1988; Powers and Hoffecker, 1989) from the same stratigraphic position is clearly younger than Younger Dryas, but is not cited in the discussion (Bigelow *et al.*, 1990, p. 164). Data from the Panguingue Creek and Owl Ridge sites are not provided; thus, it is impossible for the reader to assess the stratigraphy and sedimentology of these sites.

Additional AMS ^{14}C analyses of carefully selected samples must certainly be performed before the deposition of S1 can be reliably placed within the Younger Dryas interval. Even then, the alternative that S1 represents a single storm event conveying no climatic significance, rather than an interval of increased windiness that lasted 400 yr, cannot be excluded.

Bigelow *et al.* (1990) cite a thermoluminescence (TL) date (ITL-61) on loess 1 from the Dry Creek section, even though they were aware that this date is preliminary. The date is considered suspect because many parameters used in the age calculations were only estimated instead of measured directly (C. F. Waythomas, unpublished data). Also, the stratigraphic position of the TL sample is incorrectly plotted by Bigelow *et al.* (1990, Fig. 2). The sample was actually collected from the base of loess 1, immediately above the loess-outwash contact, rather than from loess 2 as indicated.

Proxy Records

Regardless of the absolute timing of the supposed climatic oscillation, we contend that depositional sequences from lake basins offer more continuous and higher-resolution records of climatic change than do variations in the grain size of terrace-top eolian sediments. If the climatic interpretation of the eolian deposits put forth by Bigelow *et al.* (1990) is correct, then we would expect pollen records from nearby lakes to exhibit a commensurate oscillation. However, numerous pollen studies in interior Alaska, including the Nenana Valley region, show no evidence for a climatic cooling between 11,000 and 10,000 yr B.P. (Ager, 1975, 1983; Ager and Brubaker, 1985; Barnosky *et al.*, 1987).

Rather than relying on published records proximal to the Nenana Valley, Bigelow *et al.* (1990) cite pollen evidence from the western Brooks Range and other more remote sites to support their climatic inferences. Even more disturbing is the fact that the trends in pollen accumulation rates and relative abundances cited from the published sources are inaccurate or entirely beyond the temporal resolution of the records. For example, at Kaiyak Lake, the time interval of the Younger Dryas event is constrained only by ^{14}C dates on bulk organics of 14,300 and 8900 yr B.P.; six samples were analyzed for pollen within this interval (Anderson, 1985). At Joe Lake, the chronology over the Pleistocene–Holocene transition is better constrained, but the statement that "*Populus* pollen known to be especially sensitive to summer warmth, virtually disappears between 11,000 and 10,000 yr B.P." (Bigelow *et al.*, 1990, p. 166) is not substantiated by the pollen profiles. Only a single sample in this time range lacks *Populus*, and this taxon actually reaches its late Quaternary peak accumulation rate by 10,000 yr B.P. (Anderson, 1988, Fig. 4). Interestingly, *Populus* registers its maximum accumulation rate at nearby Niliq Lake during the interval 11,000 to 10,000 yr B.P. (Anderson, 1988, Fig. 6).

Bigelow *et al.* (1990) also cite evidence from the glacial record to support their case for a regional climatic oscillation between 11,000 and 10,000 yr B.P. The chronologic control on these records is poor, and some of the moraines referred to by Bigelow *et al.* (1990) are undated (e.g., Yukon–Tanana Upland, Kigluaik Mountains). Although their observation that many Alaskan glaciers expanded during the latest Pleistocene is generally correct, the timing of these advances is too poorly constrained to use as evidence for a regionally synchronous, short-duration climatic oscillation.

CONCLUSIONS

We believe that Bigelow *et al.* (1990) have overlooked important data and failed to consider alternative hypotheses that provide more plausible explanations for the origin of sand-bearing loess in the Nenana Valley. Therefore, their attempt to correlate variations in sediment particle size with the Younger Dryas climatic oscillation is unsubstantiated by the available data. We suggest that the sedimentary variations in question are not necessarily related to climatic fluctuations. Instead, textural variations in the eolian stratigraphy may have formed in response to localized, short-duration eolian events (hours to days), or may reflect proximity to sediment sources. We doubt that "sand" unit (S1) is as temporally and spatially well-constrained as indicated by the authors.

Speculation about climatic changes in Alaska during the Younger Dryas is intriguing. Although proxy evidence for climatic oscillations during the Younger Dryas has recently been documented in southeast Alaska (Engstrom *et al.*, 1990) and the northwest Pacific (Kallel *et al.*, 1988), currently available records of environmental change in *interior* Alaska do not indicate a climatic reversal that can be placed reliably within the Younger Dryas interval.

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