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Response: Rounded quartz pebbles on accordant steps in the Southern Alps provide clues to uplift rates and crustal plate interactions *if* they are marine-terrace time lines. Ward says that they are not, but does not provide an alternative explanation for round pebbles on flat summits. In this reply, we answer Ward's criticisms and clarify our original position (*1*).

Marine-terrace remnants can be extensive (Figs. 1 and 2). None of our 200 sites of rounded quartz pebbles are on knife-edge ridge crests; they are on flat summits and gently sloping notches on spur ridge crests. The pebbles do not occur on steep valley sides, glacial deposits, and scoured bedrock and are rare or absent on steeply sloping ridge crests between flat terrace remnants. These pebbles are distinct from moa gizzard stones, which have a delicate patina (formed by slow grinding of fibrous plants) that is superimposed on any pre-ingestion high-energy-surface texture (*2*). Electron microscopy by Angus (*3*) of surface textures on 28 quartz pebbles reveals systematic changes with increase in terrace altitude from 830 to 1323 m in the Alexander and Bald ranges. Angus concludes that "quartz pebbles from lower terraces are dominated by mechanical features" and "become progressively modified by a distinctly different chemical etch in the higher terraces" (*3*, pp. 97–103).

Distinctive spacings of inner-edge altitudes allow internally consistent correlations of dated with undated terrace flights (*1, 4*). Increase of the uplift rate about 135×10^3 years ago is apparent at 14 sites along the Alpine fault. With the same analytical procedure, a contrasting tectonic style of no change in inferred uplift rate is seen in altitudinal spacings of remnants of marine terraces formed during the past 300×10^3 years at Fiordland and at Seaward Kaikoura Range sites (*4*), which are in tectonic settings different from that of the Alpine fault escarpment. Sea-level highstands recorded by coral reefs, deltaic deposits, and shore platforms may result from global climatic changes induced by variations in the earth's orbit (*5*). The "astronomical clock" is a good independent check against the radiometric chronology of New Guinea terraces. The new chronology predicts the same number of global marine terraces, but slightly younger ages for sea-level highstands result in slightly higher inferred uplift rates.

Ward's emphasis on glacial processes seems to preclude consideration of the cutting of marine benches on previously glaciated surfaces. We believe that marine, fluvial, and glacial processes interacted with uplift to create the Alpine front topography of Fig. 2. Glacially smoothed lower slopes contrast with higher rough terrain where streams have cut valleys into rising mountains. Marine platforms with round quartz cobbles and pebbles (*6*) occur as flat summits and accordant benches on spur ridges. Spot altitudes of 834 m, 831 m, 837 m, and 834 m (A on Fig. 2) are on remnants of an extensive, flat marine platform formed 214×10^3 years ago that has a shore parallel continuity of at least 2.5 km to the southwest (*3*) and of 6 km to the northeast of the 837-m spot altitude (*7*). Flat surfaces are typical of shorelines but not of streams or glaciers. This marine terrace has been raised by regional uplift, but has not been faulted or folded, which leads to the conclusion that Ward's postulated collapse of a thrust-fault escarpment has not occurred. Notches at B (Fig. 2) suggest glacial benches, but they also occur at C as ridge-crest notches flanked by fluvial valleys. This suggests that slopes at B and C were smoothed by glacial erosion, raised above subsequent glaciers, notched by several sea-level highstands, and eroded by streams. The upstream increase of valley depth west of C (20 m deep at the 200-m contour, 50 m deep at 300 m, and 95 m deep at 400 m) also supports the idea that recent glacial trimming did not reach the trimlines of earlier glaciers. We agree that in the Fox–Franz Josef area the lowest bench was modified by glaciers (*1*), but believe that higher benches and notches record process interactions similar to those described for Fig. 2.

The terrain northwest of the Alpine fault has been rising out of the sea, so future sea-level highstands will have to be higher than present sea level in order to locally notch schist southeast of the Alpine fault. Previ-

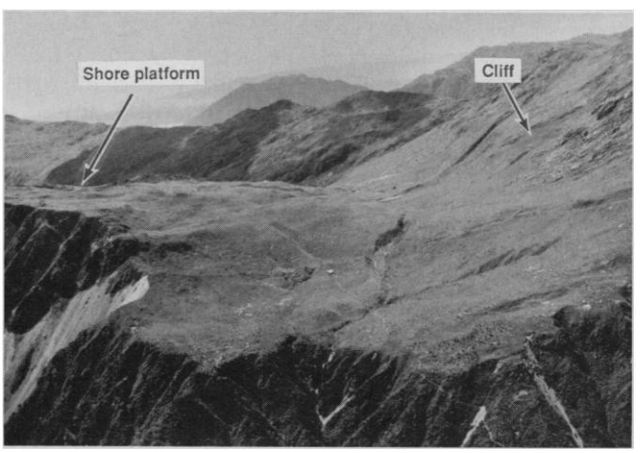

Fig. 1. Encroachment by fluvial erosion into an upland with several levels of extensive marine-terrace remnants with inferred ages of 286×10^3, 305×10^3 and 320×10^3 years ago, respectively (*5*). Arrow points to a terrace at an altitude of 1280 m that was formed 305×10^3 years ago in the Kelly and Bald ranges in the Southern Alps of New Zealand 10 km from the Alpine fault. Rounded quartz pebbles are common on shore-platform remnants, but are absent on the degraded sea cliff.

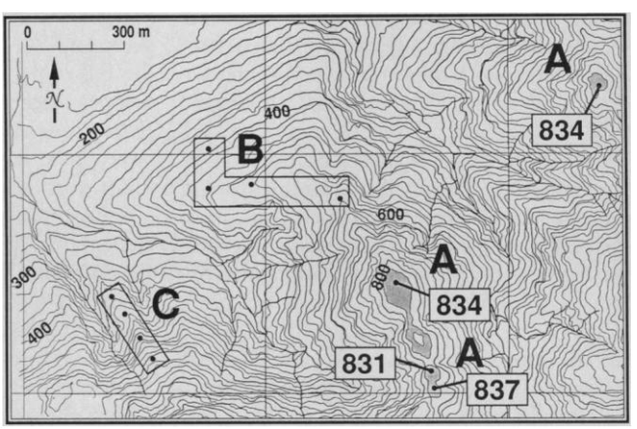

Fig. 2. Topographic characteristics of hillslopes modified by fluvial, glacial, and marine processes in the Alexander Range of the Kaniere study area of the Southern Alps (*7*). Alpine fault is near base of escarpment. Glacial and fluvial slopes have been notched by four sea-level highstands at B and C. The terrace A, formed 214×10^3 years ago, is still flat; it is 834 ± 3 m over a distance of 1.5 km. It extends northeast and southwest for a total distance of at least 8 km (*8*).

ously, marine incursions moved up major river valleys, across the Alpine fault, and deposited estuarine silts with marine bivalves in the 250-km-long region between Haast and Kaniere (*8*). Former islands and peninsulas northwest of the fault were notched by sea-level highstands; close terrace spacings indicate much slower uplift than for the Southern Alps.

We believe the available data show that the accordant steps are marine terrace time lines that can be used for inferring uplift and erosion rates. Alternative hypotheses for the origin of accordant bedrock benches with rounded quartz pebbles fail simple tests. It is apparent that moas did not violently thrash rocks in the gizzards and later deposit them selectively on flat topographic steps. Neither glaciers nor streams can account for (i) flat shore-parallel benches more than 5 km long or (ii) the presence of rounded quartz pebbles on flat summits along the main divide of the Southern Alps. Gradual spatial changes in lithospheric properties and stress fields are reflected by changes in uplift rates along the Alpine fault. The temporal doubling of inferred uplift rates at about 135×10^3 years ago may be the result of a structural realignment brought about by progressively larger convergence between the Pacific and Australian plates.

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6. Map courtesy of the New Zealand Forest Research Institute, Rotorua, New Zealand, and Bruce Harrison. Photographs of the beach cobbles and pebbles collected by Harrison from accordant bedrock steps are available from Jonathan Barran of the New Zealand Forest Research Institute, Rotorua, New Zealand.
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9. Supported by National Science Foundation grants EAR-815836 and EAR-8305892, U.S. Geological Survey contract 14-08-0001-21882, and the Otago University Research Grants Committee.

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Guanylate Cyclase and the Adrenal Natriuretic Factor Receptor

We read with great interest the paper "Coexistence of guanylate cyclase and atrial natriuretic factor [ANF] receptor in a 180-kD protein" by A. K. Paul *et al.* (*1*). However, several aspects of the data and discussion require comment.

First, the details of the purification were unclear. There is no description of the percent recovery of enzyme and binding activity or of protein. Also, it is unclear whether these preparations represent a single peak fraction off the final chromatographic step or are actually representative of the majority of cyclase and receptor molecules in these cells. It would seem important that, in a report concerned with the purification of an enzyme, these data be included.

In the legend to figure 1, the authors state that 0.12 μg of purified guanylate cyclase was separated by sodium dodecyl sulfate–polyacrylamide gel electrophoresis (SDS-PAGE). However, this amount of protein was well-visualized with Coomassie-blue staining. It is commonly accepted that the lower limit of sensitivity for detection of protein on gels with Coomassie blue with routine use is about 0.5 μg. Paul *et al.* report significantly greater sensitivity in their staining. To detect lower amounts of protein, a sensitive silver stain is required, with sensitivities down to 1 ng of protein (*2*). Thus, Coomassie-blue staining of denaturing gels is not adequate proof of purity of a protein preparation. The authors iodinated their purified guanylate cyclase preparations for isoelectric focusing. It would have been of interest if they had performed SDS-PAGE on these preparations to assess their purity.

In addition, important experiments central to the authors' hypothesis were not mentioned. For example, if the 180-kD protein contains both guanylate cyclase and ANF receptor binding activity, then it should be specifically labeled with ^{125}I-labeled ANF when this peptide is cross-linked to these preparations, as demonstrated in previous studies (*3*). Also, if the cyclase and receptor are the same molecule, then they should coprecipitate, with identical recoveries, when incubated with specific antibody directed at either activity in an immunoprecipitation assay. Paul *et al.* report having used antibodies for Western blot analysis that specifically inhibit particulate guanylate cyclase, yet they do not report the effects of these antibodies on enzyme and receptor binding activities in immunoprecipitation assays. Nor do they indicate how these antibodies were prepared. Are these monoclonal or polyclonal antibodies? What was the source of antigen, and how much antigen was used for immunization? These details would facilitate analysis and interpretation of the data.

Paul *et al.* state, "Only partial purification of any mammalian particulate guanylate cyclase has been achieved to date" and cite an earlier report (*4*). However, the copurification of particulate guanylate cyclase and the ANF receptor to apparent homogeneity from rat lung was published (*3*) 1 year before the appearance of the report of Paul *et al.* The authors do not mention this earlier report in their initial discussion and say in the latter part of their discussion only that these preparations were "highly purified," even though the earlier work provided a rigorous biochemical demonstration of the apparent homogeneity of the protein preparations and the identity of the cyclase-receptor complex (*3*).

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13 April 1987; accepted 28 December 1987

Response: Waldman *et al.* refer to three concerns: (i) lack of detail in the description of the method used to purify the enzyme; (ii) less-than-rigorous documentation of the enzyme's purity; and (iii) lack of acknowledgment of an earlier study in which the authors say they completely purified the enzyme (*1*).

Because of space restrictions, only essential features of the purification of the enzyme were provided in our report. Details that could be excluded without compromising accuracy were deleted. We will be glad to provide these details to any investigator upon request. In the legend to figure 2 of our reference 2, the specific activities of atrial natriuretic factor (ANF) binding and guanylate cyclase at specified purification steps were from single peak-activity fractions.

We did not state that a single protein band, as evidenced by the Coomasie-blue staining of the denatured gel, is absolute