Amino acids in fossil woods

THE significance of the amino acid racemisation date for fossil wood from the Kalambo Falls Prehistoric Site, Zambia, recently reported by Lee, Bada and Peterson[1] requires clarification. The specimen used for ^{14}C calibration (UCLA-1857), referred to throughout as 'Sangoan wood', is noted on Table 1 of ref. 1 as being 'Kalambo Falls, Site A, River Face (1959) Pit 3, No. 49 (9 ft 9 inch).'

Because of apparent stratigraphic correlations when this specimen was excavated, it was entered in the field catalogue as being 'Sangoan' in context; this was the notation which was on the sample when it was supplied for racemisation dating. The stratigraphy of the Site A River Face was re-examined in 1963, however, and the section drawing[2], and field notes, show that this specimen came from a bed in the uppermost White Sands and Dark Clays, from which aggregates including diagnostic Acheulian artefacts were recovered nearby. (The 9 ft 9 inch refers to a field datum; the depth below the published trench datum is 13 ft 9 inch).

That the analyses indicate that the Site A specimen is younger than that from Site B is in agreement with the postulated stratigraphic relationships[3,4] and palynological evidence[5]. Older ^{14}C dates have been obtained on wood in equivalent, Site A contexts: >49,000 (GrN 3211); >52,000 (GrN 4228); 61,700±1,300 (GrN 4896)=>60,000 (ref. 5). These would give an older racemisation date for the Site B wood.

Thus, both the analysed specimens from Kalambo Falls have Acheulian cultural associations, and the date of >110,000 for Site B has little bearing on the 'Acheulian–Sangoan transition.' It refers to the Moola Phase of the Bwalya Industry, not to the youngest Acheulian[6]. It is vital that specimens within the ^{14}C dating range be obtained for calibration, in order to derive finite dates for both of these older woods.

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Ductile shear zones and basal aureoles in ophiolite complexes

ATKINSON[1] has recently attributed ductile shear zones in the Bay of Islands ophiolites of Western Newfoundland to the 'transportation and emplacement of oceanic crust and mantle on to a continental margin'. This may be so for some such zones, although the well-exposed basal thrust of the ophiolite-bearing White Hills slice in northern Newfoundland is not associated with either the ductile style of deformation or the 'low greenschist grade' assemblages that Atkinson describes. Moreover, in the Bay of Islands complex there are well defined ductile shears in both the interbanded transition zone between the harzburgites and the gabbros and in the lower parts of the gabbros themselves, that seem to be related to processes near accreting plate margins[2,3].

These are best seen in the Lewis Hills, where a wide variety of dunites, harzburgites and gabbros are intensely mylonitised (though rarely to greenschist facies) in zones from several metres wide down to a few centimetres. These zones, many of which are axial-planar to tight folds, are cut by much less deformed dykes and sheets of hornblende gabbro, which seem to have been derived from a tholeiitic parent. Other clear evidence of the overlapping in time of igneous and deformation events is provided by the presence of rotated inclusions of foliated gabbro in relatively massive wehrlite.

It seems then that the ophiolites were undergoing deformation in narrow zones of high strain before they were carried with the spreading ocean floor far from their place of origin at an oceanic ridge or possibly at a transform. It is unlikely however, that the basal aureoles formed in the same environment by the 'lateral flowage of oceanic crust and upper mantle' as Atkinson speculates. Most of the protoliths for these aureoles were distal continental margin sediments and associated volcanics[4,5] which were overriden by the ophiolites during their advance onto the continental margin.

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ATKINSON REPLIES—Berger and Jamieson's comments on 'ductile shear zones' in the Bay of Islands ophiolites refer to high-grade structures and assemblages related, in some way, to the formation of Late Cambrian lithosphere at an ocean ridge and to its subsequent lateral flowage during sea floor spreading. I am most familiar with these previously documented structures and agree with this interpretation of their origin.

Ocean floor spreading, however, does not emplace ophiolite sheets on to continental margins. My letter to *Nature*[1] dealt specifically with younger, lower-grade minor structures formed during a late Arenig-Llanvirnian period of ocean basin closure. Crustal shortening was accommodated by telescoping the North American continental margin along major thrust faults. These were singularly responsible for the transportation and emplacement of the Bay of Islands ophiolites on to the continental margin. Field observations of the faults show that they are sharp, clear-cutting surfaces—certainly in no way 'ductile' zones themselves. My reference to ductile deformation zones (DDZ) is in regard to minor structures found within the body of the Bay of Islands ophiolite sheet. These DDZ cut across and retrograde the gabbros, harzburgites, dunites, and 'aureole' rocks, as well as all those structures mentioned by Berger and Jamieson (including the mylonites of higher-grade DDZ).

Clearly, the observations of Berger and Jamieson and previous authors on relatively high-grade DDZ related to ridge and spreading processes are not being challenged here. The observations I have made concern a distinctly later event—one that was responsible for ophiolite transportation onto the continental margin some 40 Myr later.

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