matters arising

Empirical formulae for Student's function

THE empirical formula devised by Dawson[1] for the calculation of the theoretical values of the Student's t function at any level of probability is a useful addition for many statistical programs. I have found that the following empirical formulae provide a simple method for calculating t at various defined probability levels, P:

$$P = 0.10; t = 1.64485 + 1/(0.648n - 0.534)$$
$$P = 0.05; t = 1.95996 + 1/(0.413n - 0.423)$$
$$P = 0.01; t = 2.57582 + 1/(0.193n - 0.273)$$

where n is the number of degrees of freedom. With three or more degrees of freedom these formulae give t accurate to 0.06%, 0.1% and 0.5%, respectively. A computer program using these formulae would require only the addition of the values of t for one and two degrees of freedom. These formulae are not only more accurate than Dawson's, but are also more suitable for hand calculators.

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Cape diastrophism

IN a recent paper[1] on the Cape Fold Belt, the folded strata discussed range in age from late Ordovician[2] to late Permian[3]. Until the early Permian these strata were derived from the north[4,5]. The ensuing palaeoslope reversal[6] marks the lower limit of the Cape diastrophism, and transportation of sediment from the west and south can be related to the two fold trends subsequently developed[7]. Karroo dolerites are excluded from the fold belt, and their upper age limit[8] defines the end of the diastrophism. From the Ordovician to the early Jurassic there are very real Gondwana links: for example, the Malvinokaffric fauna[9], the distribution of the Permo-Carboniferous glaciation[10], of *Mesosaurus*[11], and of *Lystrosaurus*[12]. The diastrophism was terminated by major faulting, and earliest marine sediments[13] occur in the mid-Jurassic. This was the forerunner of the spreading of the South Atlantic, which commenced at this latitude about 130 Myr ago[14]. Before that the Falkland Plateau lay immediately south of the Agulhas Bank[15].

de Beer and his coauthors proposed[1] that an oceanic plate underthrust Gondwanaland coincident with the present southern limit of Africa, and that the Cape Fold Belt resulted from an ensuing continent–continent collision directed from the south. The data given here cannot be reconciled with this suggestion for five reasons.

First, slow shelf subsidence characterised the area for almost 200 Myr before folding. Second, there are two fold trends, one parallel to the proposed direction of collision. Third, the Agulhas Bank is considered to be floored by similar material to that present onshore[16], and presents no evidence of a major suture. Fourth, the impressive similarity of the Emsian faunas of South Africa and the Falkland Islands[17] suggests that the position of the latter in Devonian times was the same as in the Jurassic. Finally the concept of a plate underthrusting Gondwanaland from the south implies that Gondwanic continents such as South America and Antarctica were not in the pre-Mesozoic positions commonly ascribed to them and consequently, that the collision would involve a continent lacking Gondwana affinities. However the Cape diastrophism may have formed, a plate tectonic model is not well served by failure to consider such material evidence.

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DE BEER ET AL. REPLY—Truswell's comments[1] deal mostly with matters outside the scope of our original letter[2], which was intended to consider geophysical anomalies near the Cape Fold Belt and, if possible, to relate these to proposed geological models. We agree that the model suggested in the paper is simplistic and could be misinterpreted.

Although the folded strata range in age from Upper Ordovician[3] to Upper Permian[4], the main phase of folding was in the Triassic[4]. The less severe, north–south trending Cedarberg folding occurred in pre-Dwyka times[4]. The first signs of a southern land mass[5] and pre-Dwyka folding in the east–west trending fold belt[4] are observable in Witteberg (Lower Carboniferous) strata. This southern land mass was not simply an uplifted part of the continental craton, but an island arc type of orogenic belt, possibly related to a subduction zone south of the present coastline[6,7].

An important point is that the Cape Fold Belt represents only the northern edge of the more extensive Samfrau geosyncline of Gondwanaland[8,9]. The orogenic belt and igneous rocks related to the inferred subduction zone are thus not in South Africa but lie in Patagonia and western Antarctica[7,9,10].

Truswell's objections to our model can be covered point by point.

First, the folding in the southern Cape occurred during Lower Carboniferous times, which means that shelf subsidence lasted only about 100 Myr before the start of any orogenesis related to subduction. Second, the degree and type of deformation accompanying continental collision (or continent–island arc collision) depend on the shapes of the continents and the morphology of the trench system, or systems, involved (see, for example, ref. 11). A fold system with only two fold trends of different ages will require a relatively simple model. The relevant geological and geophysical evidence from South America and Antarctica must be included in such a model. Third, this indicates that the