temporarily raised by ionisation. Note that such an explanation would similarly be able to explain the inclination dependence[4] of supernova rates in external galaxies, and the absence so far of Type 2 explosions in irregular galaxies.

Cas A is anomalously bright at radio frequencies, and one is tempted to conclude that it has an anomalous mass. From optical observations, one infers a mass $<1\,M_\odot$. If this mass is concentrated in a network of filaments, of electron density $>10^3\,\mathrm{cm}^{-3}$, then the X-ray luminosity can similarly stem from a mass $<1\,M_\odot$. (McKee's assumption of homogeneous shells need[3] not be realistic.) And if the velocity field of the quasi-stationary flocculi reveals[3] a peculiar velocity of $(165\pm15)\,\mathrm{km\,s}^{-1}$ of the whole remnant, towards north-northeast and towards us, then the supernova remnant must be lighter than its recoil partner (unless the latter moved even faster), again supporting a mass $\lesssim 1\,M_\odot$. in the conservative case.

This recoil partner cannot be very luminous because it has not even been detected. Very careful searches have been performed near the divergence centre of the optical knots, whereas the recoil may have removed it southwards. I think that a low mass binary containing a neutron star is a likely candidate. The neutron star's surface temperature[5] may be anything between 10^5 K and 10^7 K, depending on pion condensation in its interior. Its relativistic wind may be shielded by a cocoon formed from the wind material of its companion. And it can be the source of the cosmic rays in the nebula, and of the soft radio flare[6] which has probably occurred between 1967 and 1974. Alternatively, the recoil partner may be a second binary pulsar[7].

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Evidence for late Precambrian plate tectonics in West Africa

BLACK *ET AL.*[1] have reported further evidence for plate tectonics in the Precambrian based on their study of a 600-Myr-old collision zone proposed[2,3] along the eastern margin of the West African craton. In places, this margin is associated with a negative–positive gravity anomaly pair[4]. A case for plate tectonics in the Canadian Shield, following the initial suggestion[5] and a description of the geological evidence[6], has centred around interpretation of similar anomalies present at several structural boundaries proposed as collisional suture zones[7–10]. The type structure derived from the anomalies comprises an older crustal block, that thickens towards the suture, in steep contact with a thicker and denser, younger crustal block, both blocks being in approximate isostatic equilibrium[11]. A similar model has been proposed[12,13] for the eastern margin of the West African craton. These gravity models (Canadian and West African) are comparable with a 'basement reactivation' model proposed for collided continents[14].

We include the West African anomalies in a growing family of anomalies that seem to be collision-related phenomena reflecting a particular crustal configuration developed at suture zones. The gravity anomalies in the Canadian Shield occur along 1,800 and 1,000 Myr old orogenic belts. The addition of a 600 Myr old example from Africa suggests a continuum throughout most of Proterozoic time (1,800–600 Myr BP). Another example of paired anomalies, currently under study, along the southern Appalachians apparently extends the continuum into the Phanerozoic to ~450 Myr BP. Similar gravity signatures have been described from the Precambrian shields of Australia[15] and India[16]. Precambrian collisions proposed in Europe and South America[17] may provide more examples.

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BLACK *ET AL.* REPLY—We agree with Thomas *et al.* on the importance and significance of paired gravity anomalies along collisional suture zones, although we feel that detailed seismic information is required to perfect the model.

Note, however, that the anomalies along the eastern edge of the West African craton fall into two categories: (1) anomalies of long wavelength for which one can envisage a crustal structure similar to that proposed by Thomas *et al.* to explain coupled negative and positive anomalies along a cryptic suture. In Togo–Benin, however, in assessing the negative anomaly, one has to take into account the sediments of the passive continental margin (Buem, Atacorian). (2) Positive anomalies of shorter wavelength corresponding to more superficial unrooted structures and displaying subvertical to easterly dipping geometry in accord with the general movement pattern with thrusting towards the craton. Field observations show that these anomalies are due to basic and ultrabasic bodies emplaced along the suture[1,2].

The location of the two types of anomalies seems to be related to the geometry of the craton, which we believe reflects the original shape of the continent before collision. The first type of paired gravity anomalies occurs in Togo–Benin where the craton forms a promontory and where collision is thought to have been most intense. This situation led to the complete disappearance by subduction of the oceanic floor and of the active margin to the eastern continent, thus bringing into direct contact by underthrusting the low-grade metasediments belonging to the passive continental margin of the craton, and high-grade basement of the eastern continent. In contrast, the second type of anomalies are located in an embayment where island arc and cordilleran volcanoclastic assemblages of the active margin to the eastern continent have been preserved.

The Bouguer anomaly map of Canada suggests that several paired gravity anomalies are arcuate in form and occur along promontories, such as the Thelon front between the Slave and Churchill provinces[3].

We believe at present that the stress and deformation pattern together with the gravity signature have largely been controlled by the geometry of the colliding passive continental margin[4,5].

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0028-0836/80/110192—01$01.00