matters arising

Oblique spreading and fracture zones

REARRANGEMENT of the data on fracture zones in the North Atlantic leads to a different answer to the question raised by Atwater and Macdonald[1]: "Are spreading centres perpendicular to their transform faults?". They conclude that in slow spreading areas, like the North Atlantic, the spreading is oblique. We, however, suggest that two classes of transform faults exist—orthogonal (or near-orthogonal) and oblique. The former class has large offsets, the latter class is characterised by offsets of the order of 20 km. This relationship is shown in Table 1.

Given these two classes of transform faults, we have to decide which one represents the seafloor spreading direction. In this context we note that Searle and Laughton[2] describe the Kurchatov FZ as a zone of oblique spreading and shearing. This type of transform would occur in fracture zones with short offsets in preference to 'true' transform faults. The explanation is that the asthenospheric conduit is not interrupted over such short distances (~20 km).

Table 1 Characteristics of orthogonal (class I) and oblique (class II) transform faults

Location	Name	Angle of obliqueness	Offset
Class I			
10°50′N	Vema FZ	2°(9°)	290 km
12°10′N		~0°	45 km
12°40′N		~0°	80 km
15°20′N	Fifteentwenty FZ	3°(7°)	165 km
23°45′N	Kane FZ	0° (south)	130 km
30°00′N	Atlantis FZ	6°	40 km
35°15′N	Oceanographer FZ	0°	165 km
Class II			
13°45′N		30°–40°	16 km
16°40′N		30°–40°	18 km
17°40′N		30°–40°	~20 km
36°15′N	Fracture Zone C	17°	18 km
36°37′N	Fracture Zone B	17°	18 km
36°56′N	Fracture Zone A	17°	18 km
40°40′N	Kurchatov FZ	35°	18 km

The data between 12° and 18°N result from a recent survey (B. J. C. *et al.*, in preparation). Where our figures differ from Atwater and Macdonald's listing, their values have been added in parentheses.

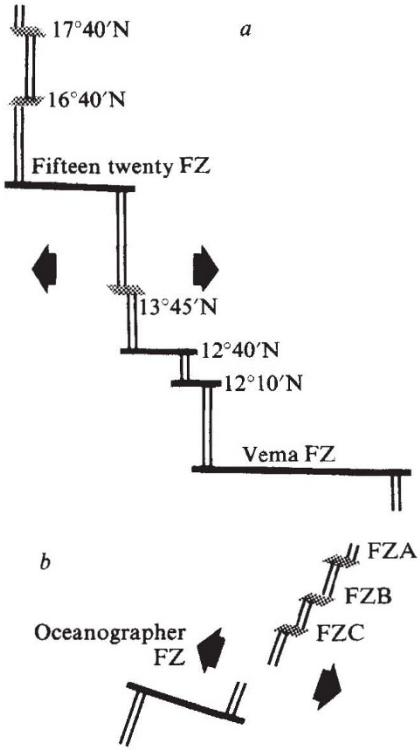

Fig. 1 Geometry of the Mid-Atlantic Ridge between 10°50′ and 18° N (*a*) and between 35° and 37° N (FAMOUS area) (*b*). Arrows indicate proposed spreading directions.

This description applies also to the 13°45′N FZ which, like the Kurchatov FZ, has no regular fossil extension but shows as an irregular zigzagging zone in the topography of the ridge flank. For the area between 12° and 18°N we therefore conclude that the spreading direction is defined by the orthogonal system of larger offset transform faults and median valley segments (Fig. 1*a*). We propose a similar interpretation for the FAMOUS area where the Oceanographer FZ would represent the spreading direction and Fracture Zones A, B and C are of the oblique spreading type (Fig. 1*b*). This explains the absence of signs of adjustment to a new spreading direction[3] near the Oceanographer FZ and is also in accordance with the circumstance that Fracture Zones A, B and C cannot be followed in the flank topography.

We left out the Charlie–Gibbs FZ from Table 1. To the north (but not directly adjoining this fracture zone) indeed 'true' oblique spreading occurs, that is, no kinematic solution can be formulated without assuming an anomalous behaviour of Reykjanes Ridge. However, for the central North Atlantic our answer to Atwater and Macdonald's question is that we have no evidence for oblique spreading in recent times other than in very narrow zones, the class of small offset fracture zones.

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3. Menard, H. & Atwater, T. *Nature* **219**, 463 (1968).

ATWATER AND MACDONALD have demonstrated that slow-spreading mid-ocean ridges may trend obliquely to the spreading normal, not perpendicular to it[1]. They suggest that the angle between ridge-trend and spreading normal may be as great as 35°–38° in two places on the Mid-Atlantic Ridge: Kurchatov FZ (41°N) and Charlie–Gibbs FZ (53°N). I believe that these two instances may be misleading as in each case it is only a short segment of ridge which displays a highly oblique trend, whereas adjacent ridge segments are nearly orthogonal to the spreading direction.

The Kurchatov FZ case was reported by myself and Laughton[2]. We believe this to be a case of oblique spreading occurring in a fracture zone instead of transform faulting: the oblique-spreading

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