A NOTE ON CLEAVAGE TONGUES

D. Broek
Nationaal Lucht-En Ruimtevaartlaboratorium
Voorsterweg 31, Emmeloord, Netherlands
tel: (020) 15 88 88

Tongues observed in electron micrographs of cleavage fractures are usually attributed to twins intersecting the fracture surface. Tongues in iron are thought to be generated when a cleavage crack growing along a (100) plane intersects a (112) matrix-twin interface and propagates on the interface for some distance, while (100) cleavage continues around the twin. Final separation occurs when the twin fractures in an unidentified manner.

Evidence for this formation process can be obtained from large angle stereographic measurements. The angle between (100) and (112) is either 35°16' or 65°54' and consequently the front flanks of the tongues should be inclined to the cleavage plane at one of these angles.

Examples of large angle stereo pictures are presented in Figure 1; comparison of the traces ABCD on these three fractographs indicates how easily parallax measurements can be made. Topographic measurements were carried out on many cleavage tongues and some results are shown in Figures 1 and 2. The tongues in these micrographs are of the most common type. It appears that their flank angle is sufficiently close to 35°16' to support the hypothesis that these tongues are due to twins. It is believed that the tongue in Figure 3 represents an example of the other possibility with the 65°54' flank angle. This type of tongue was rarely observed.

In case of an elongated twin parallel to the fracture surface, it is unlikely that the crack can surround the twin: it will first cut through the twin or the interface and then continue propagation behind the twin. Under these circumstances the twin will introduce an extended step in the fracture surface. If the crack passes through the interface the step angle will again be 35°16' or 65°54'. However, it cannot be excluded that the crack propagates along the (100) plane also in the twin. This would produce a step angle of 48°12', since the (100) planes of twin and matrix make an angle of 48°12'. Most likely there will be a preference for one of these possibilities depending upon the orientation of the twin, the direction of the tensile stress and the fracture energy of the various planes.

Steps formed by the passage of long twins parallel to the fracture surface are shown in Figure 4. Examples of the 48°12' have not been observed. In case of elongated steps however, the reliability of the topographic measurements is low, because the replica can
easily be deformed due to its low stiffness. The structure of the tongues is such that the local stiffness of the replica is high and therefore the reliability of the measurements on tongues is considered satisfactory.

30 September 1971

Fig. 1. Cleavage tongue in iron. The tongue was photographed at three tile angles. (two-stage carbon replica)