FIGURE 5.17B

(Photograph by William Savage, Pacific Gas and Electric.) (B) April 1987 photograph showing extreme sedimentation in the Quijos, Salado, and Coca river channels due to the March 5, 1987, debris flows and flooding. Note absence of the Salado River highway bridge, which had been washed out.

flood at about 0300 on March 6. There is a strong possibility that this interruption of flow of the Coca River was the result of natural damming of the river and/or its tributaries as a result of the earthquakes. We feel that short-lived damming occurred in two ways: (1) "hydraulic" damming, in which stream flow, highly charged with debris, was impeded in passing through narrow bedrock constrictions in the stream channels, and (2) blockage of streams by debris flows issuing into the main stream from its tributaries.

We have noted evidence of "hydraulic" damming at four locations in the Coca River drainage (Figure 5.19): (1) of the Salado River 7 km upstream from its confluence with the Quijos/Coca River (Figure 5.20), (2) of the

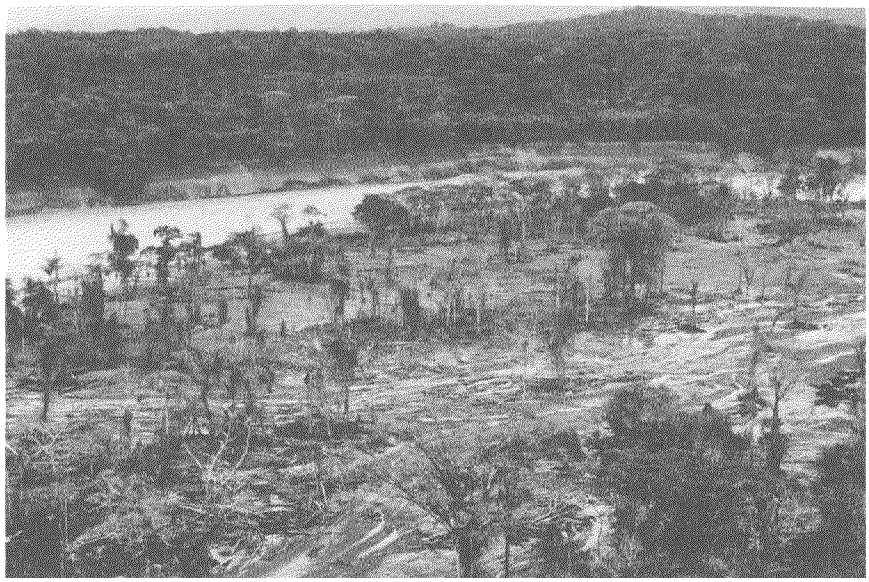

FIGURE 5.18 Evidence of March 5, 1987, flooding on the left (N) bank of the Aguarico River near the town of Lumbaqui. The flood has removed much of the vegetative cover from the low terrace in the foreground.

Malo River at its falls about 1 km upstream from its mouth, (3) of the Coca River at the bedrock peninsula that juts southward from the Salado pumping station (located at Salado), and (4) of the Coca River at San Rafael Falls. At each of these locations, the occurrence of damming is indicated immediately upstream by (1) trim lines showing the highest level of flow and (2) extensive deposits of sediment. The sediments probably were deposited in very short-lived lakes that formed as a result of damming at the constrictions before the debris "plugs" were flushed out.

The formation of temporary stream blockages by debris flows issuing from tributaries to dam the main stream has occurred in other parts of the world. For example, Montandon (1933) noted that the Upper Rhine River in Graubunden Canton, Switzerland, was briefly dammed in 1585, 1807, and 1868 by debris flows issuing from the Nolla Torrent. The Xiao River in northern Yunan Province, China, has been dammed briefly seven times in this century by large debris flows that issued from Jiangjia Gully, a major tributary of the Xiao. Each of these short-lived blockages of the Xiao River had heights of about 10 m, and most of them were overtopped and failed within a few days (Li et al., 1986). The Colorado River in the Grand Canyon was briefly dammed in 1966 by a cloudburst-triggered debris flow

from Crystal Creek (Webb et al., 1988). In the Reventador area, the only case of such debris-flow damming that we identified was caused by a flow that issued from the Malo River into the Coca River during the night of March 5-6. Apparently, this debris-flow blockage was no more than a few meters high, and it probably was overtopped and breached within an hour or two after forming. However, this low, short-lived dam must have been the main cause of the large amounts of sediment (estimated thickness: 20 m) that were deposited in the channel of the Coca River immediately upstream from the mouth of the Malo River (Figure 5.21). Possibly, another such debris-flow blockage occurred where the Salado River enters the Quijos-Coca River, because a large amount of sediment was deposited at this point (Figures 5.16 and 5.17). The same process probably occurred on a smaller scale at other locations where steep gullies flow into the Salado (Figure 5.11), Malo, and Dué Grande rivers.

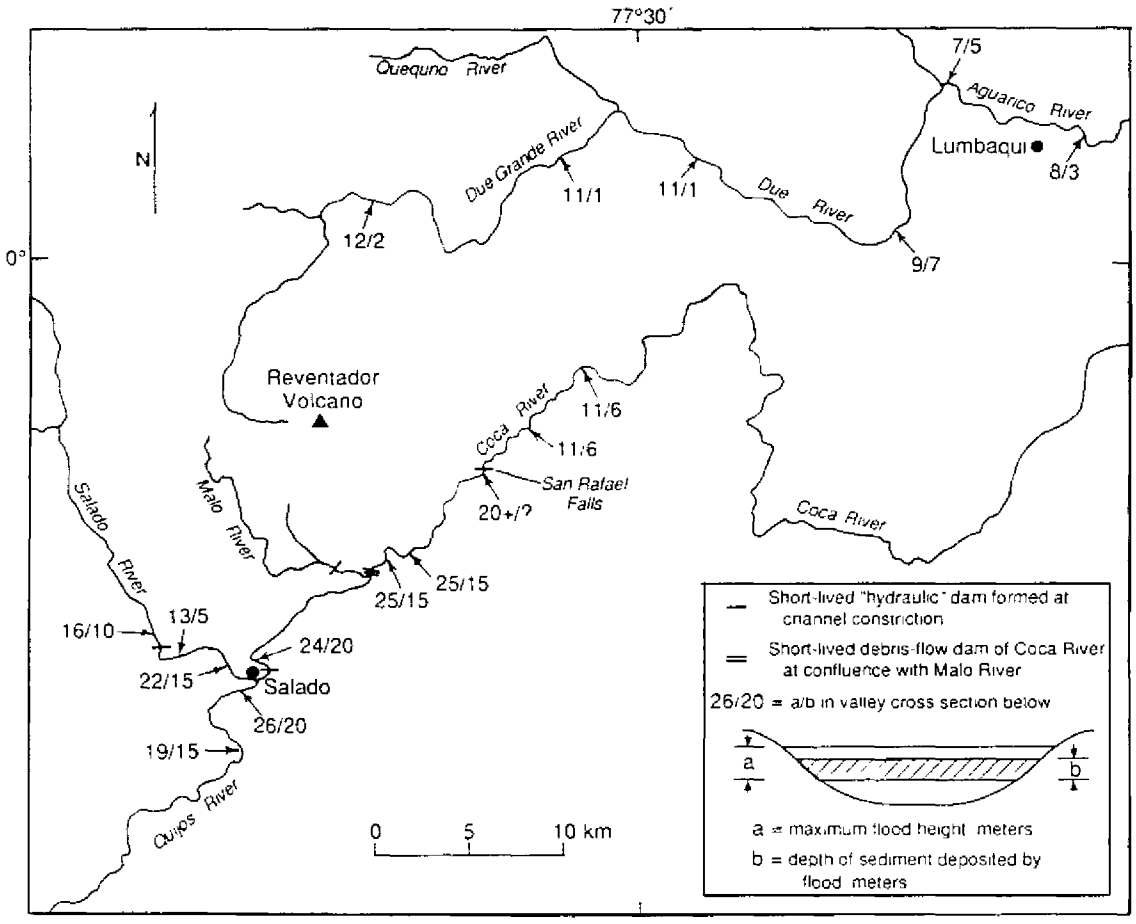

FIGURE 5.19 Estimated depths of flooding and sedimentation in river channels in the Reventador area. Estimates were based on low-level observations from a helicopter.