with a spectrum very similar to that of alkaline methemoglobin A.

On the other hand, spectrophotometric measurements in the visible and Soret regions show that only a fraction of the hemes in methemoglobin M_B give an alkaline form or react rapidly with F^-, CN^-, and N_3^- to give the normal complexes, even though the same concentrations are used that give rapid and complete formation with methemoglobins M_S and A (*9*). Treatment with H_2O_2 gives about the same fraction of the higher oxidation state. Likewise, on addition of excess $Na_2S_2O_4$, about the same fraction undergoes rapid reduction. The remaining fraction is then reduced very slowly at *p*H 7, and a little faster at *p*H 10 with a half-reaction time of about 20 minutes at 25°C. Reduction in the presence of CO follows a similar course, but at *p*H 7 the remaining fraction reacts somewhat more rapidly with a half-reaction time of about 3 minutes. Analysis of these data suggests that half of the hemes react rapidly and the other half slowly, if at all. Partial denaturation cannot be the explanation of this remarkable behavior, because upon complete reduction at *p*H 10 the Soret spectrum has a single band with its peak at 430 mμ, characteristic of a true native hemoglobin.

The reactivity and absorption spectra of the hemolysates studied by Hörlein and Weber (*2*) suggest that their methemoglobin M component resembles methemoglobin M_S. With the exception of the spectrum in alkaline solution (*4*, Fig. 3*b*), the same inference would appear to hold for the single case described both by Kiese, Kurz, and Schneider (*3*) and by Heck and Wolf (*4*). However, until data on the isolated components are available no definite conclusion can be drawn, especially since other types of methemoglobin M may exist, different from both methemoglobin M_S and methemoglobin M_B (*9a*).

Several of the abnormal features can be accounted for by the hypothesis that in acidic methemoglobin M some of the hemes are bound in a crevice so that a group from the protein occupies the sixth coordination position of the iron instead of a water molecule, which is generally accepted for the structure of acidic methemoglobin A. This would explain why only the spectrum of the acidic form is different, since the atoms directly bonded to the iron would be the same in all other derivatives. For example, if L^- is the ligand and Fe^+ the ferriprotoporphyrin iron atom, complex formation and reduction of methemoglobin A would occur:

$$\text{Globin-Fe}^+(H_2O) + L^- \leftrightarrows \text{Globin-FeL} + H_2O$$

$$\text{Globin-Fe}^+(H_2O) + e^- \leftrightarrows \text{Globin-Fe}(H_2O)$$

whereas, if a group Y, which may be neutral or negatively charged, is bonded to the iron originally, the reactions would proceed:

$$\text{Globin-Fe}^+ - \text{Y} + L^- \leftrightarrows \text{Y-Globin-FeL}$$

$$\text{Globin-Fe}^+ - \text{Y} + e^- + H_2O \leftrightarrows \text{Y-Globin-Fe}(H_2O)$$

According to this hypothesis some similarity might be expected between the spectra of the acidic forms of methemoglobins M_B and M_S and one of the typical complexes of methemoglobin A. It is therefore interesting to note that the band maxima for methemoglobin A fluoride, which are characteristic of a class of complexes with high magnetic susceptibilities, occur at almost identical wavelengths (see Fig. 2*B, C,* and *D*).

But even if the participation of crevice bonding is accepted in principle, the contrast between methemoglobins M_B and M_S is an indication of other fundamental structural differences. In methemoglobin M_B the fraction of the hemes that react rapidly may be bound normally as in methemoglobin A, while the fraction that reacts very slowly may be bound in a crevice deep within the polypeptide chains. With methemoglobin M_S, the more abnormal spectrum suggests as one possibility that a greater fraction, if not all of the hemes, are bound in a crevice configuration: yet the rapidity with which they react would require the bonding to be far more labile.

The hypothesis that the heme is situated in a crevice in normal hemoglobin has also been widely discussed, and is supported by indications of steric hindrance in the formation of its isocyanide complexes (*10*), and by more recent physical studies employing nuclear magnetic resonance (*11*). Other evidence, however, which has been surveyed in a recent review (*12*), would suggest that any such crevice configuration in normal hemoglobin enfolds the heme to a far lesser extent than the crevice present in cytochrome *c*. Furthermore, apart from the possibility of linkage via the porphyrin side chains, there is no evidence that the heme is held by more than one Fe-protein bond. X-ray studies favor a structure of this kind for myoglobin (*13*). In contrast, as proposed above, the distinguishing feature of acidic methemoglobin M, especially with the type designated Hgb M_B, may be a crevice configuration with two Fe-protein bonds (*14*).

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Field Observations on Effects of Alaska Earthquake of 10 July 1958

Abstract. The Alaska earthquake of 10 July 1958 was caused by movement on the Fairweather fault amounting to at least 21½ feet horizontally and 3½ feet vertically. Effects of strong shaking were evident over a large area in southeastern Alaska. In Lituya Bay an enormous wave, possibly resulting from a rockslide, reached a maximum height of more than 1700 feet.

Late on the evening of 9 July 1958, local time, a major earthquake was felt at most of the principal communities in southeastern Alaska and in adjoining parts of British Columbia and Yukon Territory, Canada. The U.S. Coast and Geodetic Survey has made the following determinations: instrumental epicenter, at 58.6°N, 137.1°W [in the Fairweather Range of the Saint Elias Mountains, about 100 miles west of Juneau (*1*)]; origin time, $06^h15^m51^s$ Greenwich Civil Time, 10 July 1958 (*2*). Pasadena reports Richter magnitude $M = 8$; Gutenberg unified magnitude $m = 7½$ (*3*). On Khantaak Island near Yakutat, a beach sank, carrying three persons with it, and in Lituya Bay an enormous wave killed two persons and destroyed two fishing boats.

The disturbance was strongest along the Pacific coast from Cape Spencer to Yakutat Bay; this suggests that the shock was initiated by movement along the Fairweather fault (*4*). An aerial and ground investigation of the epicentral area was started on the day after the earthquake and was continued on several days during August and early September.

The Fairweather fault, as recognized from geologic and geomorphic evidence, extends from Palma Bay at least as far northwest as the latitude of Nunatak Fiord, a distance of 115 miles. The effects of strong shaking were manifest over this entire distance; however, the surface trace of the fault is exposed in bedrock or reasonably competent mantle-rock for a total distance of only 6 miles in the vicinity of Crillon Lake and La Perouse Glacier. Elsewhere the fault trace is covered by ice, water, or recent alluvial deposits, so that the total length of the surface break cannot be determined.

A displacement in which the southwest side moved relatively northwest 21½ feet and up 3½ feet was found at one point on the Fairweather fault just east of the north end of Crillon Lake. This displacement was measured between the offset ends of a straight band of grass, near the bottom of a minor depression that crosses the fault line at a high angle. The zone of shattered soil and rock here is about 6½ feet wide and strikes N 41°W. The attitude of gouge marks or striations on a slickensided scarp near this locality substantiates the determinations of direction of relative movement and ratio of horizontal to vertical components of movement measured from the band of grass. At most places the breakage zone was found to be wider than 6½ feet and braided in appearance, and it was found to consist of two or more subparallel furrows of disturbed soil that had numerous cross breaks between and outside them.

Other displacements of right lateral movement ranging from 8 to at least 11 feet were measured between the offset segments of trees that had fallen prior to the earthquake and were partly imbedded in the soil across lines of breakage. Unfortunately, none of these trees completely spanned the entire rupture zone, so these measurements indicate only a part of the total displacement on the fault.

On bedrock ridges east of the center of Crillon Lake, flat areas on both sides of the Fairweather fault and ½ to ¾ mile from it were extensively shattered by vertical displacements along planes that strike parallel or at a low angle to the main fault. In both areas the net total relative displacement is up on the side toward the Fairweather fault. The vertical displacement makes the surface breakage in these areas look more spectacular than the breakage resulting from the larger but predominantly horizontal movement in the main fault zone.

Earth slumps, lurches, rock and soil avalanches, rockslides, earth flows, and minor cracks and fissures were observed over a large area. Slumps, avalanches, and rockslides were most numerous from Lituya Bay south, although subsidence of the beach at Point Turner on Khantaak Island, Yakutat Bay, apparently resulted from a largely submarine slump. Mud and sand erupted from vents and fissures in soft water-saturated deposits at many places from Yakutat Bay southeast to Cross Sound.

In Lituya Bay the earthquake was followed almost immediately by an enormous water wave that originated in Gilbert Inlet, one of two arms along the Fairweather fault at the head of the bay. The wave was witnessed by fishermen on boats anchored in the bay. It resulted in the almost complete destruction of the forest over an area of nearly 4 mi^2 along the shores of Lituya Bay. The trimline, or upper limit of near-total destruction of the forest, left by the 10 July wave decreases in altitude from the head to the mouth of the bay, but at most places it is much higher than similar trimlines left by earlier waves (*5*). On the steep spur separating Gilbert Inlet from the main part of Lituya Bay, the water rose to an altitude of more than 1700 feet, stripping bare to bedrock a triangular area about 1 mile wide at the base (Fig. 1). At the apex large trees were washed out and turned uphill into the undamaged forest. A large proportion of the trees felled by the wave were stripped of limbs, roots, and even bark. The earthquake triggered a large rockslide, which plunged into Gilbert Inlet opposite the highest point on the trimline. The information now available indicates that this rockslide, alone or in conjunction with fault displacement, was probably the cause of the 1958 wave in Lituya Bay.

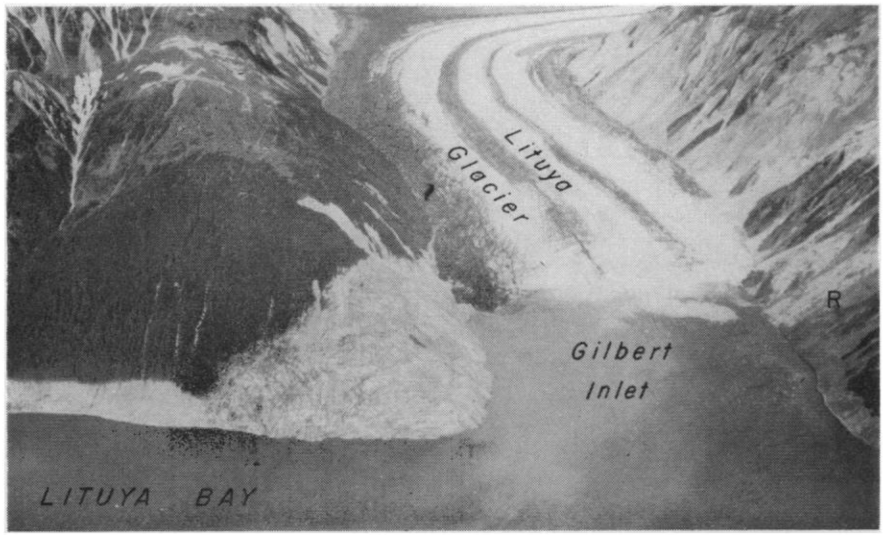

Fig. 1. Aerial view, looking north, at the head of Lituya Bay. A wave originating in the vicinity of a rockslide (*R*) in Gilbert Inlet destroyed the forest to an altitude of more than 1700 feet on the spur (left center). The trace of the Fairweather fault is covered by Gilbert Inlet and Lituya Glacier.

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