7. This mechanism rests on the assumption that the vibrational relaxation time for D_2 is sufficiently rapid to maintain almost the equilibrium population in the v-th vibrational state even though the $(v + 1)$ state is kept well below its equilibrium population by reaction. However, the relaxation time cannot be negligibly small. Only one highly provisional value for the vibrational relaxation time for hydrogen has been given [see A. G. Gaydon and I. R. Hurle, in *Eighth Symposium (International) on Combustion* (Williams and Wilkins, Baltimore, 1962), p. 309; R. C. Millikan and D. R. White, *J. Chem. Phys.* **39**, 3209 (1963)].
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15. Support from the AFOSR contract AF49(638)-716, NASA grant NsG-116-61, and AEC contract AT(30-1)-3211. The complex equipment used in this study could not have been constructed, nor could the large number of experiments have been performed without this assistance.

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Crustal Uplift Southwest of Montague Island, Alaska

During June and July of 1964 the U.S. Coast and Geodetic Survey ship *Surveyor* completed a network of reconnaissance tracklines including bathymetry in and around Prince William Sound and between Kodiak and Montague islands. Several northwest-southeast transects were run within 16 km (10 miles) of the southwest tip of Montague Island because of the faulting and uplift reported there by the U.S. Geological Survey.

A comparison of this work with a hydrographic survey made in 1927 (*1*) shows that submarine crustal uplift is up to 6 m (20 feet) greater than the maximum uplift of 10 m reported for Cape Cleare, Montague Island (*2*). The nature of the uplift is similar to that mapped on Montague Island by the U.S. Geological Survey—that is, northwesterly tilted blocks between northeast-striking, dip-slip faults. A large area of the sea floor was uplifted in excess of 9 m. Maximum uplift occurred just north of the fault where three areas of uplift exceeding 15 m are shown on the map (Fig. 1).

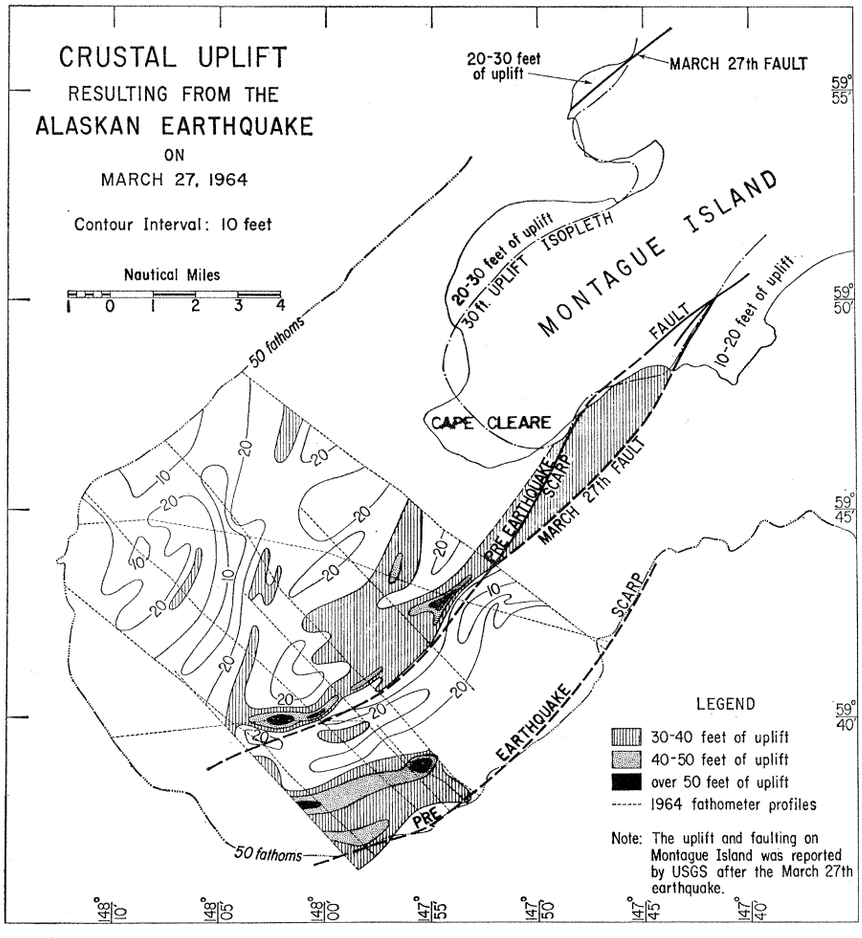

Fig. 1. Contour map of the area between Kodiak and Montague islands. The contour interval, 10 feet, is equivalent to 3 meters. Fifty fathoms are equivalent to 90 meters.

Vertical and horizontal control for the hydrography of 1927 was very strong. Depths were determined by the Submarine Signal Corporation model 312 sonic fathometer which was checked frequently by up and down lead-line casts. Navigation was controlled by measuring horizontal angles between prominent peaks. The work of 1964 was controlled vertically by the Raytheon model DE 723 recording fathometer, and the navigation was controlled mainly by Loran A and radar. The navigational control during 1927 was stronger than that in 1964, but by lining up two major scarps, which are shown in Fig. 1, the 1964 profiles were matched to the data of 1927.

The submarine extension of Montague Island to the southwest is a sediment-free tabular platform. Lead soundings in 1927, and continuous seismic profiling, bottom photographs, and cores obtained in 1964 showed the area enclosed by the 90-m (50 fathoms) isobath to be bare rock. The flatness of the rock platform makes a perfect fit of the 1927 and 1964 surveys unnecessary. Shifting the 1964 lines parallel to the scarps as much as a kilometer altered the uplift values very little. The sediment-free surface eliminates the possibility of changes in depth due to sediment deposition or seismically-induced consolidation since 1927. Tide-gauge records at nearby Seward have recorded no appreciable secular change in sea-level between 1927 and the earthquake of 27 March 1964. All of the movement is attributable to the earthquake.

Ten fathograms made in 1964 were plotted on the 1927 hydrographic survey sheet, scale 1 : 60,000. Best-fits were made with the two scarps being used for control. No shift exceeding 500 m was needed. Cross sections were then constructed with data obtained during both 1927 and 1964. The difference, crustal uplift, is presented on the contour map (Fig. 1).

The extent of the crustal uplift on 27 March 1964 cannot be traced southwest of the 90-m isobath because of the paucity of 1927 data, extensive sediment accumulation, and the sloping bottom. Another shelf area south of

Cape Cleare was detailed in 1927. This area may prove to be one of extensive uplift if analyzed by comparative surveys of the type used in this study.

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26 October 1964

Coupling of Butyl Bromide on Hot Magnesium

Abstract. *A report of the formation of octane when butyl bromide is passed over magnesium turnings at high temperatures should be amended. Such coupling does take place over pure magnesium at more moderate temperatures but yields 3-methylheptane and* sec*-butyl bromide in addition to octane.* Sec*-butyl bromide itself forms no coupling product under such conditions but admixed with butyl bromide markedly increases the 3-methylheptane:octane ratio in the product.*

A previous note in *Science* (*1*) stated that butyl bromide, when passed with helium through a tube containing magnesium turnings at 330°C, formed 10 percent of octane. Using magnesium turnings of high purity (*2*) we were unable to reproduce these findings, despite many attempts with varying tube lengths, tube geometry, contact times, and temperatures between 275° and 400°C (*3*). The effluent, condensed in ice and dry-ice traps and then freed of HBr by washing with sodium hydroxide solution, was analyzed by gas chromatography (*4*) after being dried.

Very small quantities of coupling products were obtained in only one experiment of the many carried out in the range of 300°C. In contrast, when the butyl bromide was passed over pure magnesium at 150° to 200°C, coupling could be effected routinely after a variable induction period. Yields depended on the rate of addition of the butyl bromide and careful maintenance of the experimental conditions.

Analysis of the product by gas chromatography showed the presence of 2.6 percent (of the theoretical yield) of octane (*5*), 4.4 percent of 3-methylheptane (*5*), and 3.6 percent of *sec*-butyl bromide resulting from a typical experiment when 0.8 ml of butyl bromide per minute was dropped on the magnesium turnings at 150° to 200°C in the presence of 30 ml of helium per minute. Lower boiling products were not investigated; butanes and butenes were present in significant quantities. At an addition rate of 0.02 ml of butyl bromide per minute, yields of 4.6 percent of octane, 11.6 percent of 3-methylheptane, and 2.5 percent of *sec*-butyl bromide were more typical.

When pure *sec*-butyl bromide was the feed substance, no coupling on magnesium at 150° to 200°C was detected, even though the analytical method would have shown even a few tenths of a percent of octane, 3-methylheptane, or the possible coupling product, 3,4-dimethylhexane. However, when a mixture of two volumes of butyl bromide to one of *sec*-butyl bromide was used under the usual conditions with a drop rate of 0.02 ml per minute, 1.0 percent of octane and 8.0 percent of 3-methylheptane were produced.

Although the present investigation has not established the radical or ionic character of the reaction on hot magnesium, any satisfactory mechanism must account for the several findings: the rearrangement of butyl bromide to *sec*-butyl bromide under our reaction conditions, the nonoccurrence of the reverse process, the production of 3-methylheptane from butyl bromide plus the reactive intermediate derived from *sec*-butyl bromide, and the lack of formation of 3,4-dimethylhexane from *sec*-butyl bromide.

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2. Sublimed magnesium was provided through the courtesy of J. F. Pashak of the Wrought Development Section of the Dow Metal Products Company.
3. This negative finding is not disparaging to the results of Turk and co-workers; it points up the complexities of the reaction. Small quantities of metal impurities in the magnesium influence the course of the reaction, and temperatures in the reaction tube may vary widely unless unusually careful control is exerted.
4. A Research Specialties gas chromatograph fitted with a 2-m Apiezon L column (about 10 percent on 60–80 mesh Chromosorb P) and a katharometer detector were used for analytical runs. Quantitative results were verified by calibration with known mixtures.
5. Identity was conclusively established by infrared analysis (Perkin-Elmer 237 spectrophotometer) of macroquantities which were isolated from the product mixture by an Autoprep gas chromatograph (Wilkens Instrument and Research, Inc.) fitted with a 6 m × 0.9 cm column filled with 20 percent SE-30 on 60–80 mesh Chromosorb W.
6. This work was initiated by a Research Corporation grant. The authors thank D. F. Clark for preliminary studies and designs of equipment. W.D.E., N.F.P., and C.F.F. were aided in their work by the National Science Foundation undergraduate science education program under grants GE-2797, GE-987, and GE-12126.

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Rubidium-Strontium Isochron Study of the Grenville Front near Lake Timagami, Ontario

Abstract. *Rubidium-strontium isotopic analyses of whole-rock samples and of constituent minerals from a suite of rocks taken across the Grenville Front demonstrate that granitic rocks of the Superior province, with a primary age of approximately 2.4 billion years, and older metasedimentary rocks were reconstituted during Grenville metamorphism, at approximately 930 million years, and now form part of the Grenville province.*

In understanding the evolution of continental masses, the question of the growth of continental bodies through geologic time is of fundamental importance. Parts of the North American continent have been subdivided on the basis of geologic characteristics and apparent age. With regard to the hypothesis of continental accretion it is necessary to determine whether the geologically younger parts of the continental masses represent the addition of new material or are in fact the product of metamorphism of the older pre-existing geologic provinces. The boundaries between old and young provinces are the natural places to study these possible phenomena. Reported herein are some of the characteristics of a portion of the boundary zone between the Grenville and Superior provinces as shown by a study of strontium and rubidium isotopes.

The Grenville Front is the northwestern boundary of the Grenville province of the Canadian Shield (see Fig. 1). For over 800 miles it forms the boundary between the Superior and Grenville provinces (*1*, *2*). These provinces differ in particular in structure and in grade and age of major metamorphism. The easterly trending structures of the Superior province are truncated on the southeast by the northeasterly trending structures of the Grenville.