tion always showed a higher concentration of CO and the unsaturated hydrocarbons than its partner. In all illuminated samples, where there was an increase in concentration of a component, the increase was greatest in set C (highest DOC concentration), intermediate in set B (intermediate DOC concentration), and lowest in set A (no added DOC). In the one experiment where DOC was added to natural seawater, however, the greatest increase of CO in the dark was in set A, and the least was in set C (Fig. 1).

The world ocean may be a source of CO (*8*). The situation with respect to the unsaturated gaseous hydrocarbons has yet to be clarified. Dissolved organic matter appears to constitute the major reservoir of organic material in the oceans (*9*), and our work suggests that it is one source from which CO and the unsaturated gaseous hydrocarbons might be produced in the illuminated zone. Additional, and perhaps greater, production by organisms is also possible. The nature of net production of CO and hydrocarbons in the ecosystem is not known.

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2. The gas chromatographic column used in most of the experiments did not separate ethane from ethylene (see *7*); consequently only the combined concentration of these gases is shown. However, these gases were separated in some later experiments, and only ethylene was produced in the cell-free systems. Moreover, other analyses show that the ethane-ethylene system usually follows the same pattern of production as propane and propylene.
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4. Bacterial contamination may have no apparent effect or it may cause serious changes in the concentrations of one or more gases. For example, one strain caused the concentration of CO to decrease rapidly to zero with a concomitant production of CH_4.
5. The DOC was determined by a modification of the procedure of D. W. Menzel and R. F. Vaccaro [*Limnol. Oceanogr.* **9**, 138 (1964)]. In our hands, the method shows "DOC" concentrations of 0.20 to 0.25 mg of carbon per liter in distilled water blanks.
6. We used discarded stock cultures of various diatoms and flagellates. The cultures were of various ages and had been grown in artificial seawater enriched with nitrate, phosphate, silicate, trace metals, and vitamins and buffered with tris-(hydroxymethyl) aminomethane-HCl. Each culture was checked for sterility before being used.
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Properties and Composition of Lunar Materials: Earth Analogies

Abstract. *The sound velocity data for the lunar rocks were compared to numerous terrestrial rock types and were found to deviate widely from them. A group of terrestrial materials were found which have velocities comparable to those of the lunar rocks, but they do obey velocity-density relations proposed for earth rocks.*

Certain data from Apollo 11 and Apollo 12 missions present some difficulties in that they require explanations for the signals received by the lunar seismograph as a result of the impact of the lunar module (LEM) on the lunar surface (*1*). In particular, the observed signal does not resemble one due to an impulsive source, but exhibits a generally slow build-up of energy with time. In spite of the appearance of the returned lunar samples, the lunar seismic signal continued to ring for a remarkably long time—a characteristic of very high Q material. The lunar rocks, when studied in the laboratory, exhibited a low Q (*2*). Perhaps most startling of all, however, was the very low sound velocity indicated for the outer lunar layer deduced from the LEM impact signal. The data obtained on the lunar rocks and fines agree well with the results of the Apollo 12 seismic experiment (*2*, *3*). These rock velocities are startlingly low. The measured velocities on a vesicular medium grained, igneous rock (10017) having a bulk density of 3.2 g/cm^3 were $v_p = 1.84$, and $v_s = 1.05$ km/sec. The results for a microbreccia (10046) with a bulk density of 2.2 g/cm^3 were $v_p = 1.25$ and $v_s = 0.74$ km/sec for the compressional (v_p) and shear (v_s) velocities.

It was of some interest to consider the behavior of these lunar rocks in terms of the expected behavior based on measurements of earth materials. Birch (*4*) first proposed a simple linear relation between compressional velocity and density for rocks. This relation was examined further by Anderson (*5*) who showed that this was a first approximation to a more general relation, derivable from a dependence of the elastic moduli with the density through a power function. Comparison of the results obtained from the returned lunar rocks with the predictions of these relationships expresses graphically the manner they deviate from the behavior of rocks found on earth. The velocities are remarkably lower than what would be predicted from either the Birch or Anderson relationships.

To account for this very low velocity, we decided to consider materials other than those listed initially by Birch (*4*) or more detailed compilation of Anderson and Liebermann (*6*). The search was aided by considerations of much earlier speculations concerning the na-

Table 1. Comparison of compressional velocities of lunar rocks and various earth materials.

Lunar rocks and cheeses	v_p (km/sec)	Sedimentary rocks	v_p (km/sec)	Metamorphic rocks	v_p (km/sec)	Igneous rocks	v_p (km/sec)	Minerals	v_p (km/sec)
Sapsego (Swiss)	2.12	Dolomite	5.6	Schist	5.1	Granite	5.9	Corundum	10.8
Lunar Rock 10017	1.84	Dolomite	4.69	Slate	5.39	Syenite	5.7	Periclase	9.69
Gjetost (Norway)	1.83	Limestone	5.06	Charnockite	6.15	Diorite	5.78	Spinel	9.91
Provolone (Italy)	1.75	Limestone	5.97	Gneiss	4.9	Oligoclase	6.40	Garnet	8.53
Romano (Italy)	1.75	Greywacke	5.4	Marble	6.02	Andesite	5.23	Quartz	6.05
Cheddar (Vermont)	1.72	Greywacke	6.06	Quartzite	5.6	Gabbro	5.8	Hematite	7.90
Emmenthal (Swiss)	1.65	Sandstone	4.90	Amphibolite	6.70	Gabbro	6.8	Olivine	8.42
Muenster (Wisconsin)	1.57			Eclogite	6.89	Norite	6.50	Trevorite	7.23
Lunar Rock 10046	1.25					Diabase	6.33	Lime	7.95

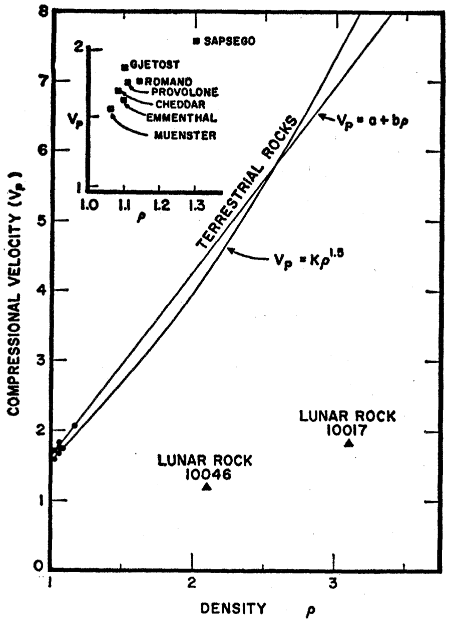

Fig. 1. Comparison of the velocity of sound for rocks with that of earth materials.

ture of the moon (*7*), and a significant group of materials was found which have velocities that cluster about those actually observed for lunar rocks.

These materials are summarized in Table 1, where, for emphasis, common rock types found on earth are listed for comparison. The materials studied were chosen so as to represent a broad geographic distribution in order to preclude any bias that might be introduced by regional sampling. It is seen that these materials exhibit compressional velocities that are in consonance with those measured for the lunar rocks—which leads us to suspect that perhaps old hypotheses are best, after all, and should not be lightly discarded.

A comparison of these low velocity materials with the predictions of Birch and of Anderson is shown in Fig. 1. It is at once apparent that these materials do yield values of velocity that are predicted by these relations for their densities. Thus the curve of Birch for the rock types diabase, gabbros, and eclogites fit the cheeses surprisingly well. This apparent inconsistency, in that the cheeses do obey these relationships by having a velocity appropriate to their density, in contrast to the lunar rocks with which they compare so well, may readily be accounted for when one considers how much better aged the lunar materials are.

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Calorimetric Detection of a Membrane-Lipid Phase Transition in Living Cells

Abstract. *The membrane lipids in living* Mycoplasma laidlawii *exhibit a phase transition characteristic of that from crystal to liquid crystal within the bilayer conformation. The transition occurs at the same temperature in viable organisms, membranes isolated from the organisms, and isolated membrane lipids. The enthalpy of the transition in the membrane is compared with that of an aqueous suspension of isolated membrane lipids. The result is consistent with presence of an extended lipid bilayer in the native membrane.*

Membranes of *Mycoplasma laidlawii* undergo a reversible endothermic phase transition at a temperature dependent on the lipid composition of the membrane (*1*). That is, the more unsaturated the fatty acid chains of the membrane lipids are, the lower the transition temperature is. Aqueous dispersions of extracted lipids have transitions at the same temperature as the membranes from which they were extracted (*1*). These results were interpreted as evidence for the bilayer conformation of lipids in the membrane by analogy with the well-established behavior of aqueous dispersions of phospholipids, which exhibit crystalline to liquid crystal transitions of the hydrocarbon tails within the bulk lamellar array (*2, 3*). This interpretation has been corroborated (*4*) with low-angle x-ray diffraction, which showed that the spacings below the transition are characteristic of a lattice of hexagonally packed hydrocarbon chains within a lamellar array. The x-ray results rule out extensive hydrophobic associations of lipid and protein.

We report here that the membranes of viable *M. laidlawii* undergo this transition and that the transition occurs at the same temperature in the organisms, membranes isolated from the organisms, and lipids extracted from the membranes. We also report the enthalpy per gram of lipid for the transition in intact membranes and in aqueous suspensions of the extracted lipids.

Mycoplasma laidlawii (strain B, PG9) were grown at 37°C in lipid-free tryptose medium supplemented with palmitic acid (*5, 6*). Under these conditions, 65 to 70 percent of the fatty acids of the membrane lipids are palmitate. Growth was monitored by measuring optical density at 500 nm with a Zeiss spectrophotometer. Cells in the middle of the logarithmic phase of growth were collected at 19½ hours by centrifugation and washed with 0.25*M* NaCl at 4°C. Membranes were prepared by osmotic lysis (*5*) followed by centrifugation at 100,000*g* for 50 minutes at 4°C. The membranes were resuspended in a buffered medium of *p*H 8 consisting of 0.03*M* tris(hydroxymethyl)aminomethane, 0.2*M* NaCl, and 0.005*M* $MgCl_2$. They were then resedimented for calorimetry.

Lipid was extracted from the membranes by the method of Folch *et al.* (*7*). All protein remaining in the organic phase was denatured by evaporation to dryness and removed by filtration. The lipids were dried to constant weight under vacuum to remove all traces of organic solvent before they were suspended in the buffer for calorimetry. The amount of lipid per unit weight of membrane pellet was determined by weighing the lipid recovered by the extraction procedure described above.

Calorimeter scans were made in a Perkin-Elmer DSC-1B differential scanning calorimeter with a modified sample head at full-scale sensitivity of 1 mcal per second and a scan rate of 5° per minute. Scans were begun at 0°C, and stearic acid was used to calibrate the apparatus (temperature and power).