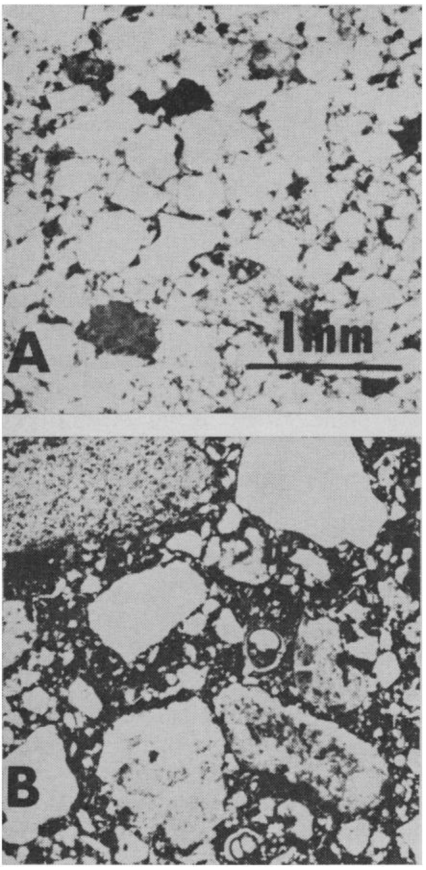

Fig. 1. Photograph of a thin section through (*A*) core V 7-42 (135 cm), subarkose-type sand; and (*B*) core V 7-55 (355 cm), graywacke-type sand (× 25). Light-colored grains are quartz and feldspar. Note abundant dark-colored interstitial matrix in *B*. The thin sections are obtained from portions of cores that have been impregnated with epoxy resins, sliced, mounted on glass, and ground to the standard thickness of 30 μ.

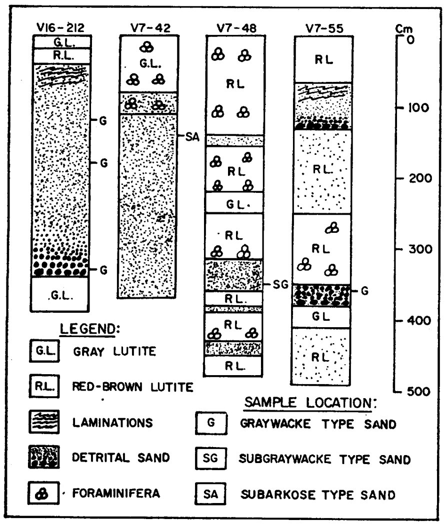

Fig. 2. Graphic descriptions of four sediment cores from the Sohm Abyssal Plain. Cores V 16-212 and V 7-55 contain graywacke-type sands. Cores V 7-42 and V 7-48 contain subarkose and subgraywacke-type sands that are typical of most abyssal plain sands studied.

The framework grains of the two graywacke-type sands are well sorted. There were no grains larger than 2 mm and 88 percent of each distribution falls within two classes (2.0-1.0 mm and 1.0-0.5 mm). The fine admixtures decrease rapidly to less than 0.02 percent between 0.06 mm and 0.03 mm. As the fine matrix (<0.02 mm) makes up at least 20 percent of the sample volume (Table 1), it is apparent that this sediment is strongly bimodal and that the fine fraction forms a secondary mode in the original material. Similar bimodal distributions are typical of ancient graywackes (see *6*).

Although minor postdepositional changes may have occurred, it is concluded that this fine matrix is a primary feature of the sediment and that both were deposited simultaneously. The emplacement of matrix by burrowers has been suggested as a mechanism to produce graywackes from clean sands (*7*); however, the clean sands of the abyssal plains are found to depths several times the maximum depth reached by burrowers.

Although graywacke may be produced by later filling of the pore spaces of subgraywacke-type sediment during diagenesis, the occurrence of primary, modern deep-sea sands of the graywacke type indicates that postdepositional alteration is not always necessary. The predominance of the clean "subgraywacke-type" sands over muddy "graywacke-type" modern sediments in the deep sea, however, suggests that postdepositional alteration is an important factor in graywacke genesis.

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8. This report is Lamont Geological Observatory Contribution No. 754 and was supported by the U.S. Navy Office of Naval Research. Reproduction of this report in whole or in part is permitted for any purpose of the United States Government. We benefited from discussions with K. O. Emery, F. J. Pettijohn, J. Schlee, and R. Siever.

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Variations of Nitrogen-15 Abundance in Soils

Abstract. *A survey of the isotopic composition of soil nitrogen has shown that there is variation in the abundance of nitrogen-15 in soils and in different forms of soil nitrogen. The variation detected is small, but it cannot be attributed to analytical errors and should be considered in studies of nitrogen transformation in soils when nitrogen-15 is used as a tracer.*

Variations in the relative abundance of nitrogen isotopes in the atmosphere and in natural materials such as peat, coal, oil, rain, rocks, minerals, and leaves have been reported (*1*). No survey of variation in nitrogen isotopic abundance in soils appears to have been made, but there is evidence to indicate that variation does occur (*2*).

The isotopic abundance of the nitrogen in different soils and in various forms of soil nitrogen has been studied by analysis of the nitrogen isotope-ratio of a wide variety of soil samples, including samples from virgin and ad-

Table 1. The N^{15}-content (ΔN^{15}) of the nitrogen in soils.

Soil type*	Sample depth (cm)	Total N (%)	ΔN^{15}
Edina SiL (V)	0–15	0.30	+2
Edina SiL (C)	0–15	.17	+1
Grundy SiCL (V)	0–15	.35	+16
Grundy SiCL (C)	0–15	.20	+10
Hayden SiL (V)	0–15	.28	+2
Hayden SiL (C)	0–15	.16	+7
Sable SiCL (N)	0–15	.21	+11
Sable SiCL (N)	15–30	.20	+12
Sable SiCL (N)	30–45	.14	+14
Sable SiCL (T)	0–15	.24	+4
Sable SiCL (T)	15–30	.21	+11
Sable SiCL (T)	30–45	.13	+16
Cisne SiL (N)	0–15	.11	+3
Cisne SiL (N)	15–30	.09	+6
Cisne SiL (N)	30–45	.06	+5
Cisne SiL (T)	0–15	.15	+3
Cisne SiL (T)	15–30	.11	+7
Cisne SiL (T)	30–45	.07	+5
Fargo SiC	0–15	.30	−1
Harpster SiL	0–15	.36	0
Sceptre C	0–15	.32	+1
Naicam SL	0–15	.30	+2
Clinton SiL	0–15	.18	+4
Houston SiC	0–15	.19	+8
Promise C	45–75	.09	+17

* SiL, silt loam; SiCL, silty clay loam; SiC, silty clay; C, clay; SL, sandy loam; V, virgin soil; C, cultivated soil; N, soil receiving no residue or fertilizer treatments in long-term rotation experiment; T, soil receiving periodic treatments of residue, lime, phosphorus, and potassium in long-term rotation experiment.

Table 2. The N^{15}-content (ΔN^{15}) of various forms of nitrogen in soils.

Form of nitrogen	Soil type*				
	Grundy SiCL	Hayden SiL	Austin C	Clarion SiL	Glencoe SiCL
Total	+16	+7	+5	+3	+2
Hydrolyzable:					
Total	+18	+10	+7	+5	+4
Ammonium	+7	+7	+3	+6	+5
Hexosamine	+25	+8	0	+2	−2
Amino acid	+16	+14	+12	+5	+8
Hydroxyamino acid	+19	+11	+8	+7	+3
Nonhydrolyzable	−3	−2	−1	0	−4
N—mineralized†	+6	+2	+1	+1	+1
Fixed ammonium	+6	+6	+4	+2	0

* SiCL, silty clay loam; SiL, silt loam; C, clay. † Inorganic nitrogen produced by incubation of the soil at 30°C and at 50 percent water-holding capacity for 2 weeks.

jacent cultivated soils and from various depths in the profiles of soils receiving different treatments, and by determining the N^{15} content of various forms of nitrogen in soils. The methods used for determination and isotope-ratio analysis of different forms of soil nitrogen have been described (*3*). Variation in N^{15} content, expressed as ΔN^{15}, was calculated as follows:

$$\Delta N^{15} = \frac{\begin{pmatrix}\text{Atom-}\\ \text{percent } N^{15}\\ \text{in sample}\end{pmatrix} - \begin{pmatrix}\text{Atom-}\\ \text{percent } N^{15}\\ \text{in standard}\end{pmatrix}}{\text{Atom-percent } N^{15} \text{ in standard}} \times 10^3$$

Some of the data obtained are presented in Tables 1 and 2. They show that there is a significant variation in the nitrogen isotope-ratio of soils and of different forms of soil nitrogen. The data indicate that the N^{15} content of the nitrogen in soils ranges from slightly below the generally accepted value for the natural abundance of N^{15} (0.366 atom-percent N^{15}) to appreciably above this value, the average being 0.368 atom-percent N^{15}, or $\Delta N^{15} = +5$. Among the various forms of soil nitrogen, the amino acid and hexosamine fractions tend to have higher N^{15} contents than the other fractions, but the data are not consistent.

In selecting a reference standard for calculation of ΔN^{15}, some have assumed a constant value as natural abundance (*4*), and others have determined the N^{15} abundance separately, using atmospheric nitrogen, compressed nitrogen, or deoxygenated air as standard (*5*). For this work, a reference nitrogen gas sample obtained from the National Bureau of Standards and a sample of reagent grade ammonium sulfate from a commercial source were used. The nitrogen-isotopic abundances in these two materials were determined by the Ames Laboratory of the U.S. Atomic Energy Commission and found to be the same (0.3663 atom-percent N^{15}). The ammonium sulfate was preferred as the reference standard. In a precision study that we made, using the ammonium sulfate standard, 12 samples were analyzed, and the amount of N^{15} in the standard was found to be 0.3663 ± 0.0001 atom-percent.

The precision of the method used to determine the N^{15} content of soils is further illustrated by the data obtained from analysis of a Marshall silty clay loam soil of Iowa. Five samples of this soil were subjected to Kjeldahl digestion (*3*), and two portions of each digest were distilled and titrated to obtain a total of ten ammonium samples for analysis of N^{15}. The abundance of N^{15} in this soil, as determined by mass spectrometer analysis of these samples on four different dates by two independent operators, was 0.3677 ± 0.0004 atom-percent.

The methods used in our work for isotope-ratio analysis of different forms of nitrogen in soils were developed from systematic studies of sources of error in N^{15} analyses (*6*). For the mass spectrometer analysis, we used a Consolidated Electrodynamics Corporation mass spectrometer model 21-620 modified to include an isotope-ratio accessory and a linear d-c electrometer amplifier.

The gas conversion system used was built on the mass spectrometer so that the nitrogen gas produced from the ammonium sample was introduced directly into the instrument. Extensive testing of our methods indicates that they are accurate and precise. Therefore, the variation detected by these methods cannot be attributed to analytical errors.

In conclusion, the variation in the isotopic composition of soil nitrogen appears to be small and, for many investigations of the fate of N^{15}-enriched compounds in soils where N^{15} is used as a tracer, this variation can probably be ignored. However, for studies in which N^{15} added to soils is diluted many times (for example, in investigations of nitrogen transformations resulting from long-term biological and nonbiological reactions in soils), the natural variation in the N^{15} content of soils and of different forms of soil nitrogen must be considered for proper evaluation of the results.

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Marshes Prograding in Oregon: Aerial Photographs

Abstract. *When nearly circular clumps of vegetation abound in aerial photographs of mud flats in estuaries in regions of temperate climate the indication is that the marsh is expanding rapidly.*

The most obvious indicators of the expansion of tidal marshes in estuaries on the Oregon coast are numerous, nearly circular, colonies of marsh plants. In a study of seven estuaries