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=         DEEP SEA DRILLING PROJECT          =
=  Gamma Ray Attenuation Porosity Evaluator  =
=                 DATA BASE                  =
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I. INTRODUCTION

A. BACKGROUND AND METHODS

The Gamma Ray Attenuation Porosity Evaluator or GRAPE data base is the result of a project which standardized the processing and formatting of all DSDP GRAPE data. The data base allows data from different legs and holes to be compared directly if the investigator is satisfied with the following two presumptions:

1) Full core liners (no geometric corrections)
2) Grain density = 2.70

The method of re-calculating the GRAPE data when one or both of the above conditions is not appropriate is discussed below. The symbols and definitions used in the following discussion are:

Symbol	Definition	DSDP assigned value
RHOF	Sea water density	1.025 gm/cc
MUF	Associated attenuation for RHOF	0.110
RHOG	Grain density	2.70 gm/cc
MUG	Associated attenuation for RHOG	0.100
RHOBC	Initial bulk density estimate by liner interpolation with standards.	-- calculated --
MUQTZ	Presumed attenuation coefficient of bulk sample	0.100
RHOB	Final bulk density (file value)	-- calculated --
PHI	Porosity (fractional)	-- NOT calculated --

Symbol	Definition	DSDP historical value
DIAM	Gamma path length through bulk sample.	6.61 cm = full liner
RHOSL	Estimated density of material surrounding bulk sample when DIAM < 6.61 cm.	0.00 gm/cc = air 1.50 gm/cc = 'slurry'
MUSL	Associated attenuation for RHOSL	0.100

I. Calculation of Porosity from RHOB

(1) PHI = (RHOG-RHOB)/(RHOG-RHOF)

This is the standard equation for defining porosity. It can be used directly only when RHOG=2.70 and RHOF=1.025 since these are the same values used in deriving the file value RHOB.

II. Re-calculating RHOB with Chosen Values for RHOG and RHOF

(2) PHI = (RHOG*MUG-RHOBC*MUQTZ)/(RHOG*MUG-RHOF*MUF)

Equating relations (1) and (2) allows RHOBC to be derived from RHOB by using the above default values for RHOG, MUG, RHOF, MUF, and MUQTZ. Porosity (PHI) can then be calculated as an intermediate step in re-calculating RHOB with new values assigned to any of the other variables.

III. Geometric (gamma path length) correction to RHOBC

RHOBC = RHOBC*(6.61/DIAM) - (6.61/DIAM - 1)*RHOSL*MUSL/MUQTZ

With DIAM=6.61(cm) the above equation reduces to RHOBC=RHOBC (no correction). Thus the correction is used only when the gamma path length DIAM is less than the standard core liner diameter.

The accuracy of calculated GRAPE bulk density and porosity values may be limited more by the accuracy to which the above defined independent parameters are known than by the inherent limitations of the apparatus itself. This is certainly true for a large percentage of the values calculated in the file described here where a full liner and a grain density of 2.70 gm/cc have been assumed. For this reason, it is important to discuss each of the independently specified parameters used in the GRAPE calculation from the viewpoint of their potential adverse effect in determining bulk density and porosity values.

Gamma Ray Path Length Through the Material (DIAMETER)

In the case of hard rock recovery where broken rubble or a uniformly small diameter section is recovered, the percentage DIAMETER deviation from the nominal 6.61 cm section diameter will result in a similar percentage discrepancy between the actual and calculated bulk density values. Thus, without specific information on the gamma ray path through the sample, the calculated densities should be considered a lower bound on the actual bulk density. This same concept obviously applies to sedimentary recovery as well where, in addition, the material itself may have been seriously disturbed by drilling. Diameter correction measurements have been recorded for many DSDP legs in the 'GRAPE LOG' which is part of the DSDP microfilm collection maintained at the NGDC. Hardrock and consolidated sedimentary recovery are most likely to have had extensive diameter correction measurements. Here is a partial list of legs where such measurements have been made: 33, 35, 38, 42, 43, 50, 56, 58, 60, 61, 63, 65, 71, 75, 76, 78 and 79. The core photo collection can also be examined to determine the quality and character of core recovery.

RHOSL

This parameter is assigned a value only when a re-calculation is done with a DIAMETER value less than 6.61 centimeters. With no specific value provided by the 'GRAPE LOG' microfilm records or by any other resource, the most probable assignment is RHOSL = 0.0 gm/cc (i.e., the surrounding material is air).

Attenuation Coefficients (MUF,MUG,MUQTZ)

The attenuation coefficients of the major mineral components of most marine sediments can be represented by a single uniform value without introducing 'undue' error in calculating GRAPE bulk density and porosity values. This assumption requires that the gamma ray source be adjusted to the correct energy level. An investigator would have to be familiar with the particular GRAPE apparatus and its theory before using attenuation coefficient values different than the default values listed above.

Grain Density (RHOG)

The assumed file value of this parameter (2.70 gm/cc) is an approximate mean for much of the DSDP sedimentary recovery. The re-calculation of bulk density and porosity with

different RHOG values that the bulk density value is far less responsive to changes in RHOG than is the porosity value. Each investigator must make his own quantitative assessment of the 'sensitivity' of these values from the viewpoint of his own research objectives.

Sea Water Density (RHOF)

The default value of this parameter is sufficiently precise with respect to the distribution of actual sea water densities that a replacement value should have no significant effect on the bulk density and porosity calculations.

Each record of the file represents a core section (nominal 1.5 meters) and is prefixed by the standard 11 character DSDP label. The GRAPE apparatus continuously scans a single section from end to end and then halts until the operator manually initiates scanning for the next section. Standards may be run at any time and section densities are always calculated with respect to the most recently run standard of the appropriate type. Anomalously high isolated density values sometimes are found within an otherwise representative density profile. Such values should be considered suspect because of hardware and procedural errors that are known to so manifest themselves. In particular, a high density at the very beginning or very end of a section probably results from operator error in aligning the scanner with respect to the brass cylinders that are placed at both ends of a section. Because of these and other considerations, a straightforward averaging of the density values of this file would be a poor method of characterizing the actual density profile of a section; some simple algorithm based on 'highest sustained densities' within a section will undoubtedly yield better results.

B. LEGS IN THE DATA SET

The data base contains data from all legs except Leg 96. Approximately 1 of every 1.9 sections recovered by the DSDP were successfully scanned and processed for inclusion in the GRAPE data base.

C. REFERENCES

Boyce, R.E., 1976, Leg 33, Definitions and Laboratory Techniques of Compressional Sound Velocity Parameters and Wet-Water Content, Wet-Bulk Density, and Porosity Parameters by

Gravimetric and Gamma Attenuation Techniques. In: Schlanger, S.O., Jackson, E.D., et al., 1976, Initial Reports of the Deep Sea Drilling Project, Volume XXXIII. Washington (U.S. Government Printing Office) pp. 931-958.

II. FORMAT AND FIELD DESCRIPTIONS

A. DATA FORMAT

Record length = 684 characters

COLUMN	FIELD	FORMAT
1-2	LEG	A2
3-5	SITE	A3
6	HOLE	A1
7-9	CORE	A3
10-11	SECTION	A2
12-19	TOP OF CORE DEPTH (meters)	F8.2
20-27	CENTER OF FIRST DENSITY DEPTH (meters)	F8.2
28-33	DENSITY POINT INCREMENT (centimeters)	F6.3
34	SOURCE CODE ("T","E","L")	A1
35	STANDARD CODE ("S","D","A")	A1
36-39	GAMMA IDENTIFIER: LOW DENSITY STANDARD	I4
40-43	GAMMA IDENTIFIER: HIGH DENSITY STANDARD	I4
44	space	X1
	DENSITY VALUES: The number of values per record varies with the data source (T,E,L):	
45-684	T = TUCSON DATA	160F4.2
45-644	E = EARLY CHALLENGER DATA	150F4.2
645-684	space	40X1
45-584	L = LATE CHALLENGER DATA	135F4.2
585-684	space	100X1

B. FIELD DESCRIPTIONS

The definition of leg, site, hole, core and section may be found in the explanatory notes. In addition, the special core designations, as well as the methods of sample labeling and calculating absolute sample depths are discussed.

TOP OF CORE DEPTH:

The subbottom depth in meters to the top of the core.

CENTER OF FIRST DENSITY DEPTH:

The subbottom depth in meters to the center of the first averaged density.

DENSITY POINT INCREMENT:

The distance in centimeters between consecutive density points.

SOURCE CODE:

T = TUCSON DATA (Digitized from strip charts by *D.C.S.)
E = EARLY CHALLENGER DATA (Pre-leg 71)
L = LATE CHALLENGER DATA (Legs 71-96)

* Digitgraph Computer Systems
Box 5907
Tucson, Arizona 85703
U.S.A.

STANDARD CODE:

Each standard consists of two parts as outlined below. As a point of information, the gamma ray attenuation of 2.54 cm of aluminum is approximately equivalent to 6.61 cm of water.

CODE LOW DENSITY STANDARD HIGH DENSITY STANDARD ===
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S Sea water (6.61 cm) Aluminum (6.61 cm) D Distilled water (6.61 cm) Aluminum (6.61 cm) A Aluminum (2.54 cm) Aluminum (6.61 cm)

GAMMA IDENTIFIER FOR STANDARDS:

The value is derived from the standard calibration run that was used in processing the section. Taken together, the low and high density gamma identifiers should constitute a unique couple that allows the investigator to see when (sequentially) a new standard was run. For 'Challenger' data the file value is 1000*(LOG BASE 10 OF AVERAGE GAMMA COUNT). For 'Tucson' data the value represents the linear units of the strip chart trace of the standard.

DENSITY VALUES:

Density values are averaged to give approximately one value for every centimeter of section. Since the sampling interval was different for each of the three data sources (see DATA SOURCE), the number of samples averaged for each type of data varies. The table below lists for each data source the number of samples averaged, the length in centimeters represented by each averaged density and the number of averaged densities present

in each data record. The length of every record is the same regardless of the number of density values calculated for a section. Records with less than 160 density values are completed with blank space. Any densities which did not fall between 1.03-4.50 g/cc were considered to be either voids or data spikes and were assigned a value of zero.

SOURCE	SOURCE CODE	NUMBER OF COUNTS AVERAGED	LENGTH (cm) PER AVERAGED DENSITY	NUMBER OF DENSITIES IN RECORD (one section)
Tucson	T	5	0.938	160
Pre-Leg 71 Challenger	E	3	1.023	150
Legs 71-96 Challenger	L	2	1.142	135

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