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Founder of GranoMetry™ Science with Applications

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Jiří Březina — Founder of GranoMetry™
Science with Applications

Having been involved in sedimentological research with practical applications (finding oil and gas in marine sand deposits) for the past sixty years, I realized that:

- Sand sediments are controlled only by the transitional hydrodynamic regime, which determines their dispersity (granularity) characteristics; the dispersity of finer and coarser sediments is not controlled by interpretable hydrodynamics, but by chemical and post-genetic processes such as in clays or by fragmentation and gravitational processes as in gravel.
- Only the settling rate of sand grains that replaces their sieve grain size reflects directly the sedimentation hydrodynamics, which in turn can be disclosed by sedimentation analysis. The classical description of sand deposits by their sieve grain size has been formal and has not permitted any useful interpretation.
- Isolated normal distribution components are required to replace distribution moment descriptors. The currently used distribution description by moments is formal and does not allow genetic interpretation.

By Courtesy of Lois Lammerhuber/Edition Lammerhuber, Austria

GranoMetry™ — what is it?

I assigned to my new approach the trade mark GranoMetry™, a composite word meaning measuring (Greek metron) grains, particles (Latin granum).

Success through Technology and Computers

The latest technology and computers that developed from analogue (1963) to digital (1973), from mini- to PCs, has enabled solutions previously unimaginable. This uncompromising approach resulted in success for my clients when using my products.

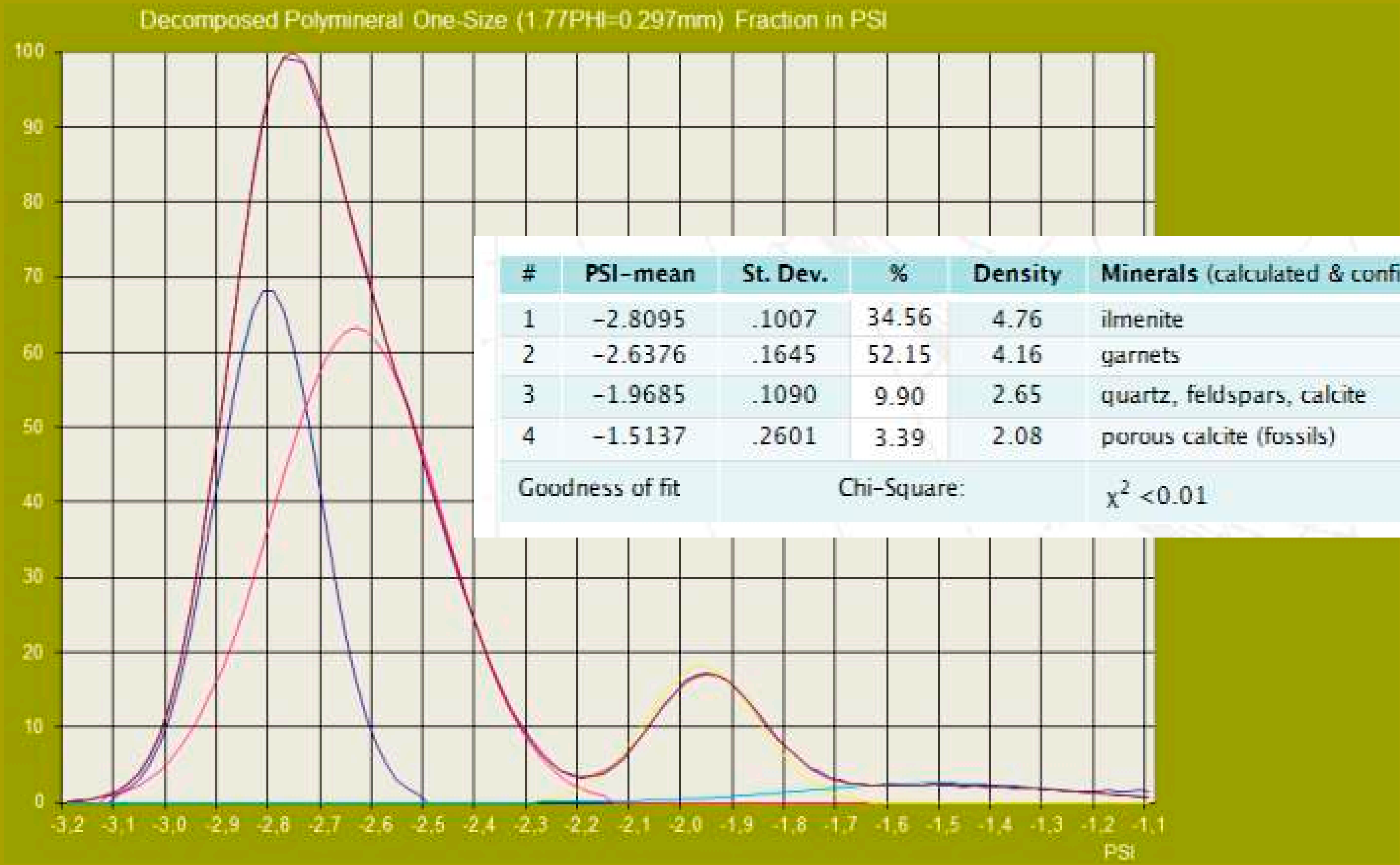
Instruments and Applications

During my studies in 1955-1968 while working for the Central Geological Survey (UUG) of Czechoslovakia on marine deposits (with a maximum thickness of more than 5 km) of Miocene age (23 to 5 million years ago) in the West Carpathian Mountain system of Moravia and Slovakia, I encountered large quantities of monotonous sandy deposits. In order to characterize them, distinguish sedimentation units and facies, and reconstruct their sedimentation basins with provenance issues, I sought distinctive features of these sands, especially after the standard micropaleontological tools (foraminifera) had failed. Unfortunately, even minerals and their chemistry failed.

The only property of sand, which could reveal the sought-after features, was sand granularity — or better to say, dispersity — described by the statistical distribution of a suitable dispersity unit. While working on my PhD, I found that in water-deposited sands, the negative asymmetry of their PHI-size distribution disappears when the log settling velocity is taken as the dispersity unit (J. BREZ INA, 1963).

Only grain size distribution, determined by sieving, was available as a standard method. This is why I started developing my own sedimentation technique. Initially, I had hoped that the recently invented settling tube — such as the Woods Hole Rapid Sediment Analyzer (1960) — could be the solution: it was inexpensive, rapid and convenient. After I developed a highly sensitive pressure sensor for this type of settling tube, this method reached its limit, because it required such a high suspension concentration that it caused significant errors from streaming and particle interactions.

My pressure sensor was so sensitive that even a low spoken voice interfered with the measured signal. The reason was simple: particle frequency measured by the suspension density (pressure difference) required too high of a suspension concentration. Only the amount of sediment (weight) should be measured, i.e. without water (only enough to reduce the particle concentration).



#	PSI-mean	St. Dev.	%	Density	**Minerals** (calculated & confirmed)
1	−2.8095	.1007	34.56	4.76	ilmenite
2	−2.6376	.1645	52.15	4.16	garnets
3	−1.9685	.1090	9.90	2.65	quartz, feldspars, calcite
4	−1.5137	.2601	3.39	2.08	porous calcite (fossils)
Goodness of fit		Chi-Square:			$\chi^2 < 0.01$

So, I started developing a sensitive and rapid underwater balance. My design consisted of steel leaf springs arranged in a parallelepiped to compensate for asymmetric load (BREZINA 1972, German patent 2251838). To allow for the optimum operation of the balance, I shielded it from environmental vibrations and passed its output through own mathematical filter. To limit the concentration effects up to the settling tube top, I constructed a sample introduction device, which disperses the sample in the upper 5 cm of the settling tube: an electrically driven Venetian blind with eccentrically rotating concave lamellae that vibrate in the open position for approximately 3 seconds.

To convert the settling velocity into grain size and vice versa, I developed a universal sedimentation equation (BREZINA 1978, PARTEC): it is valid for fine particles (Stokes' law), coarse particles (Newton's law), the intermediate range of particles and, for irregular natural particles whose shape is specified by Corey's Shape Factor, S F (COREY 1949, independently McNOWN and J. MALAIKA, 1950), in addition to spheres. The particle shape greatly influences the settling velocity of sand particles.

Finally, I revised the distribution characteristics: I found that only Gaussian distribution and the first two moments have physical meaning, whereas the higher (3rd and 4th) moments do not. I divided the measured distributions into a few (up to 5) Gaussian components using the program by Isobel CLARK (1977, ROKE) that has a unique algorithm. The first two moments and percentages of the Gaussian components define and sufficiently specify each sample.

In this manner, I completed a system of hardware and software that is efficient for the study of sand dispersity. The distribution components of settling velocities also reveal those of the horizontal stream motion (due to inertia) and thus permit the reconstruction of the sedimentation basins. Because all the 14,000 samples that I processed and archived from 1955 through 1968 have since been discarded, I initiated a new study of Miocene sands from Moravia.

To study the settling velocity sand fractions, I developed a Sand Sedimentation Separator™, 3S™. This instrument, when used for sedimentation separation of equal-sized grains, such as sieve fractions, allows the separation of grains into fractions of the same density, which is unique for separating heavy minerals and microfossils, such as foraminifers.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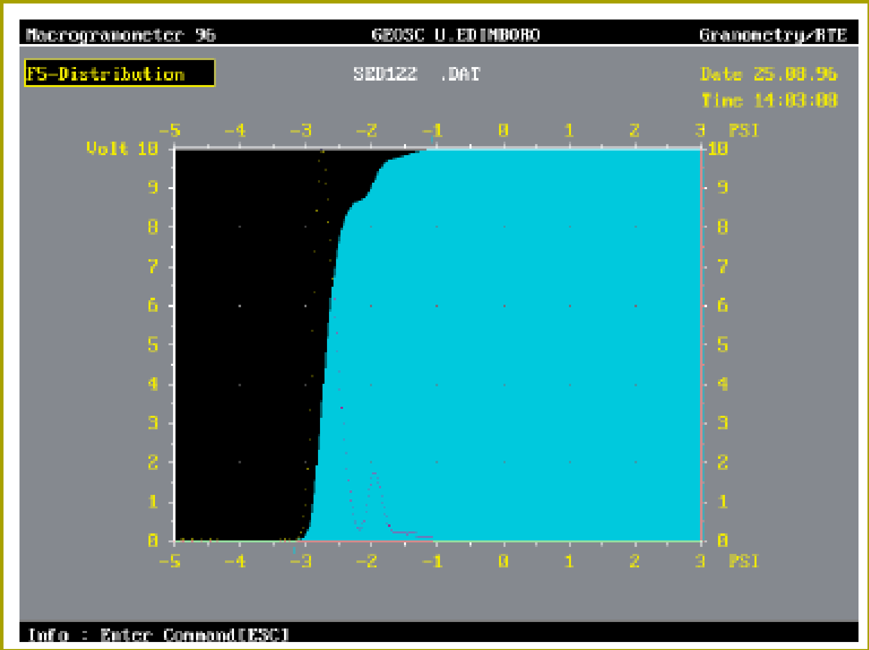

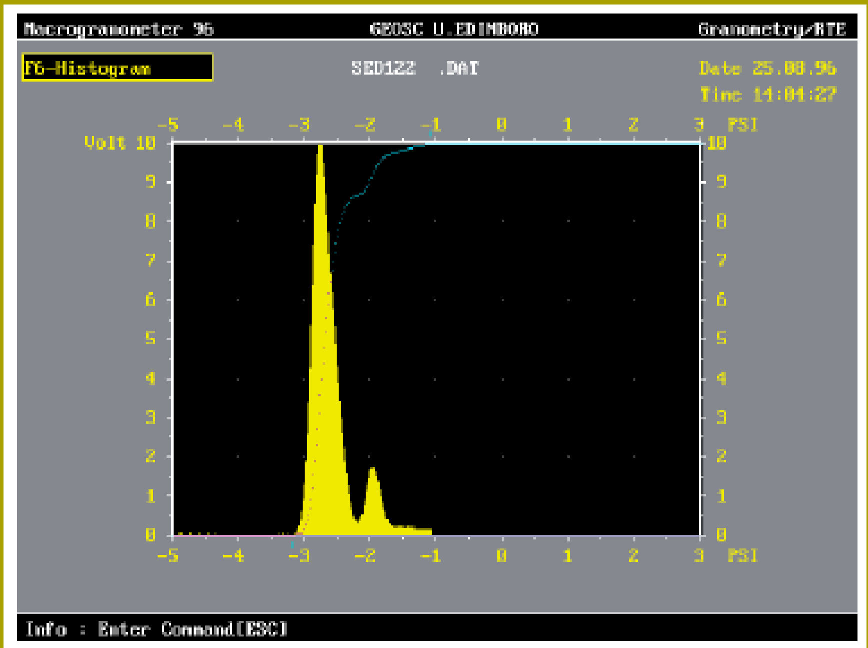

Show Distribution Window (F5)

This window shows the results of the Analysis as described in Figure 7. Here the fi le sed122.dat was read in: the analysis of the polymineral narrow sieve fraction from Maracaibo (see Material, page 13). During sedimentation, synchronously with the sediment deposition on the Underwater Balance, a cumulative (distribution) curve in light color grew by vertical increments from left. After the analysis terminated (PSIENDwas reached), also the differential (frequency) curve displayed as small white & blue dots (histogram).

Show Histogram Window (F6)

Data of the Figure 5 with opposite highlight: the differential (frequency) curve, histogram, is emphasized by light color.

BEST SAND SEDIMENTATION

Laboratory Instruments & Software

lab PRODUCTS

Instruments

- Sand Sedimentation Analyzer, MacroGranometer™, Advanced Settling Tube
- Sand Sedimentation Separator™, 3S™

Software

- SedVarDP™ — Distribution Processing software
- SedVarNC™ — Number Conversion software
- Shape™ — distribution decomposition and distribution percentile matching software


ANALYSIS
items meet your
Good
Excellent

Our SERVICES (available soon)

- analyzing your samples
- processing your analyses

Applications in

- geology
- oceanography
- ecology
- mechanical & chemical engineering (in German: mechanische Verfahrenstechnik)
- quality control
- forensic research & analysis
- planetology

Summary

1. Only the category of sandy clastic sediments has a property, which allows their origin to be interpreted: the settling rate distribution of their grains.

2. Grain size distributions were studied for half a century after the World War II. For 3 reasons they did not provide the expected results:

a) A wrong variable was used for interpretation: grain size instead of settling rate;

b) The wrong distribution characteristics were sought unprofessionally - a 'magic' combination of higher moments, asymmetry (skewness) and kurtosis (peakedness) were uselessly combined;

c) Half-hearted method efforts - cheap devices, by their inherited streaming and particle interaction errors, wasted money and time.

3. A precisely measured distribution is either directly defined by a normal (Gaussian) distribution or, as a mixture, by 2-5 normal (Gaussian) components. Dr. Joseph R. Curray (1961), director of the Scripps Institution of Oceanography, La Jolla, CA , had successfully demonstrated this by transport routes (he called the components "natural tracers"). Though he used the grain size as a variable and a manual graphical decomposition without the aid of a computer, his exemplary pioneer work opened the door to genetic interpretations.

4. Since then, I have dedicated myself systematically to all the tasks necessary to carry on

this work. I have investigated experimentally and theoretically the necessary conditions for sedimentation analysis and developed the appropriate hardware and software.

5. In the Journal of Sedimentary Petrology (1963), I documented that the normalizing distribution variable is not the logarithmic grain size but, instead, the logarithmic settling rate. My BETA variable was the decadic logarithm of the settling rate in mm/sec. Gerald V. MIDDLETON (1967) dubbed it PSI and chose a binary logarithm of the settling rate in cm/sec. The so-called Kapteyn's transformation of the grain size distributions eliminated their negative PHI asymmetry and made the resulting log-settling rate distributions Gaussian (normal). This is the most solid proof of a distribution variable correctness.

6. The distribution decomposition into components determines requires the highest standards for the measuring of distributions. My Sand Sedimentation Analyzer ™ (MacroGranometer ™) meets all these requiements. Most importantly:

   a) As a precise sedimentation balance, it permits unhindered sedimentation and thus measures of the smallest representative samples;

   b) Samples are not only introduced into the settling tube but also dispersed;

   c) The underwater balance provides not only high resolution (± 20µg), but also a time constant as short as only 26 milliseconds;

   d) To further enhance its sensitivity, the settling tube is isolated from environmental vibrations, and the balance signal is cleaned from noise by own mathematical filter.

Jiří Březina — Thoughts

The basic memento of life is **truth.** A lie is an error, therefore a loss of time, which we are given so little since our birth — what is our witness of hundred revolutions of our planet around a star, which we call a century against the existence of the world.

An unfulfilled promise is type of a lie, a falsehood, unfortunately intentional, even though it follows from inexperience. But our inexperience does not help the matters: „we are responsible for our words, even death cannot excuse us. So the next life memento is **responsibility and reliability**".

The next life memento is **seeking:** already the first self-replicating RNA molecules have it inherited — the precursors of life. These life precursors, in order to get along the environment, had to passively observe and humans had to actively ask — the learning process which enhances finding and knowing.

Knowing enables and requires **doing.**

Reaching a goal does not need to be a success: it may be destructive. A very common reason for the extinction of a species had often been its success.

To quantify the world, we compare its components with a **scale.** However, each scale depends on the quantity: each size, amount, duration have their scaling, each can only be properly evaluated if compared with similar values — each scale must be **relative,** which means **logarithmic** (Weber – Fechner law).

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