**STABLE ISOTOPES δ13C & δ15N IN SOILS & SOLIDS BY CONTINUOUS FLOW ISOTOPE RATIO MASS SPECTROMETRY**

# 1. Principle – This method describes the determination of Delta N15 v Air and/or Delta C13 v VPDB in soil, sediments, plant, or biologic material by flash combustion. There are two naturally occurring stable isotopes of both nitrogen - 14N (99.634%) and 15N (0.366%), and carbon 12C (98.89%) and 13C (1.11%). An aliquot of sample is combusted under oxygen where the carbon and nitrogen contained in the sample is converted to gas form. Gases CO2 & N2 are separated chromatographically, then analyzed in a CF-IRMS. Intensities of mass 46/45/44 for CO2 and mass 28/29/30 for Nitrogen are measured. Internal standards are calibrated against the International Reference scale (i.e. C13 vs. VPDB and N15 vs. Air). Raw data from the mass spectrometer is then referenced to PDB or Air using a linear regression calculated from the internal standard results.

# 2. Instrument Used: ThermoFinnigan Delta+ Advantage Continuous Flow Isotope Ratio Mass Spectrometer (CF-IRMS). Thermo Finnigan Corp, Bremen, Germany, 2003.

**3. References:**

**3.1** Official Methods of Analysis of AOAC International, 17th Edition (2000), AOAC International, Arlington, VA. Method 972.43, Micro-chemical Determination of Carbon, Hydrogen, and Nitrogen, Automated Method.

**3.2** Methods of Soil Analysis, Part 3 – Chemical Methods, Soil Science Society of America Book Series #5, Soil Science Society of America, Inc., Madison, Wisconsin. Dumas Methods, Determination of Total Nitrogen and Total Carbon by Combustion.

**3.3** ECS 4010 Elemental Combustion System CHNS-O Operating Manual, Costech Analytical Technologies Inc., Valencia, CA.

**3.4** P.A. de Groot, Handbook of Stable Isotopic Analytical Techniques, Volume 1, Elservier, 2004, ISBN:0 444 511148

4. **Standards Used**:

**4.1 Calibration Standards:** For C13: NBS22 (-29.7 δ13CVPDB), LSVEC (-47 δ13CVPDB), and NBS19 (+1.95 δ13CVPDB), purchased from NIST. For 15N: IAEA-N1 (+0.4 δ15NAIR), IAEA-N2 (+20.3 δ15NAIR), IAEA-N3 (+2 δ15NAIR), purchased from NIST.

**4.2** **Laboratory Internal Standards:** BMO (-23.91 δ13CVPDB/+8.2 δ15NAIR), NBS (-26.3 δ13CVPDB/+0.907 δ15NAIR), Pea Grain (-24.68 δ13CVPDB/+2.429 δ15NAIR), & Corn Stover (-12.5 δ13CVPDB/+9.1 δ15NAIR).

**4.3** **External Reference Standards:** Red Clover (-27.42 δ13CVPDB/-0.56 δ15NAIR )