**Stable Isotopes for Environmental Monitoring**

- Significant component of environmental research
  - Used for monitoring of landfill contamination, determining source stray gas in soils, and deciphering the origin and fate of nitrate in surface ground water
  - Isotopes in precipitation, combustion, volcanic activity, etc...
  - Concentrations for greenhouse gas determination, natural air monitoring
- FOCUS: Development of new ambient concentration isotopically characterized CO₂ standards that meet WMO DQO objectives

**Validate Pressure Reduction from the Cylinder to IRMS Doesn’t Cause Fractionation**

1. **Experimental configuration**
   - Step 1: Gas expansion into 2 L, taking segment
   - Step 2: After equilibration, expanded into 2 L
   - Step 3: 0.3 bar transferred to sample cylinder

2. **CO₂ flowing at 2 L/min: Analysis by FTIR**
   - Low dead volume, 2 stage / piston regulator reaches steady state faster

3. **Depletion of LCO₂ Cylinder**
   - 21 Kg LCO₂ cylinder
   - Withdrawal at ~500 mL/min to eliminate possibility of droplet formation in the gas stream
   - If the withdrawal rate is too high to prevent equilibration, droplets of LCO₂ will alter the data

**Summary**

- Careful regulator selection eliminates possibility of fractionation
- Enriched C comes off first leaving the reservoir depleted in ¹³C as the product bleeds off
- Depleted O comes off first leaving the reservoir enriched in ¹⁸O as the product bleeds off
- For precise measurements meeting the WMO DQO, gaseous sources must be used and verified for each use