



November 10, 2006

Ms. Salley Moorhead  
15395 WCR 47  
LaSalle, CO 80645

RE: Complaint #200098048  
NESE Section 14 - T3N - R65W  
Weld County, Colorado

Dear Ms. Moorehead:

As you are aware, Colorado Oil & Gas Conservation Commission (COGCC) environmental staff collected water samples from your water well for laboratory analyses on October 17, 2006. The samples were submitted to Severn Trent Laboratories, Inc. in Arvada, Colorado, for organic and inorganic analyses. This well was previously sampled by COGCC staff on March 31, 2006. Laboratory results from this sampling event were summarized in COGCC correspondence dated April 21, 2006. This letter summarizes the analytical results of the recent water samples collected from your new water well. Copies of the laboratory analytical reports are included with this letter.

#### COMPARISON OF INORGANIC ANALYTICAL RESULTS TO STANDARDS

The analytical results for the recent water sample from your well and applicable ground water and/or drinking water standards are summarized in this letter. The Water Quality Control Commission (WQCC) of the Colorado Department of Public Health and Environment (CDPHE) has established these standards. Please keep in mind that the human standards were established for public drinking water supplies, and often people use and consume ground water from private wells that exceed the standards.

- Total Dissolved Solids (TDS): The TDS standard for human drinking water is 500 milligrams per liter (mg/l). Although CDPHE does not have an agricultural standard for TDS, other agencies recommend concentrations below 2,000 mg/l for irrigation, and below 5,000 mg/l for most livestock watering.

TDS was detected in the recent water sample from your new well at a concentration of 640 mg/l. This is greater than the human drinking water standard, greater than the recommended maximum concentration for irrigation, and greater than the recommended maximum concentration for most livestock watering.

TDS was detected in the 3/31/06 water sample from your new well at a concentration of 620 mg/l. This is greater than the human drinking water standard, greater than the recommended maximum concentration for irrigation, and greater than the recommended maximum concentration for most livestock watering.

- Sodium (Na): Although the CDPHE does not have a standard for sodium, people on salt restricted diets should be aware of the sodium concentration in the water they drink. A concentration of less than 20 mg/l is recommended by some for people on salt restricted diets or for people suffering from hypertension or heart disease. Sodium occurs naturally in the ground water in many areas at concentrations that exceed the recommended level.

Sodium was detected in the recent water sample from your new well at a concentration of 280 mg/l, which is greater than the recommended level.

Sodium was detected in the 3/31/06 water sample from your new well at a concentration of 260 mg/l, which is greater than the recommended level.

- Chloride (Cl): The CDPHE chloride standard for human drinking water is 250 mg/l. Chloride concentrations in excess of 250 mg/l usually produce a noticeable taste in drinking water.

Chloride was detected in the recent water sample from your new well at a concentration of 73 mg/l, which is within the human drinking water standard.

- Sulfate (SO<sub>4</sub>): The CDPHE sulfate standard for human drinking water is 250 mg/l. Although CDPHE does not have an agricultural standard for sulfate, other agencies recommend a concentration below 1,500 mg/l for livestock watering. Waters containing high concentrations of sulfate, typically caused by the leaching of natural deposits of magnesium sulfate (Epsom salts) or sodium sulfate (Glauber's salt), may be undesirable because of their laxative effects.

Sulfate was not detected in the recent water sample from your new well.

Sulfate was not detected in the 3/31/06 water sample from your new well.

- Total Nitrate (NO<sub>3</sub>) + Nitrite (NO<sub>2</sub>) as Nitrogen (N): The CDPHE total nitrate (NO<sub>3</sub>) + nitrite (NO<sub>2</sub>) as nitrogen (N) standard for human drinking water is 10 mg/l. Nitrate and Nitrite are common contaminants in ground water from agricultural sources, such as fertilizer and animal wastes. They are known to cause infant cyanosis or "blue baby disease" in humans and, at concentrations greater than 100 mg/l as nitrogen, may be dangerous to livestock.

Total nitrate (NO<sub>3</sub>) + nitrite (NO<sub>2</sub>) as nitrogen (N) was not detected in the recent water sample from your new well.

Total nitrate (NO<sub>3</sub>) + nitrite (NO<sub>2</sub>) as nitrogen (N) was not detected in the 3/31/06 water sample from your new well.

- Iron (Fe): The CDPHE iron standard for human drinking water is 0.3 mg/l. Small amounts of iron are common in ground water. Iron produces a brownish-red color in laundered clothing, can leave reddish stains on fixtures, and impart a metallic taste to beverages and food made with it. After a period of time iron deposits can build up in pressure tanks, water heaters, and pipelines, reducing the effective flow rate and efficiency of the water supply.

Iron was not detected in the recent water sample from your new well.



Iron was not detected in the 3/31/06 water sample from your new well.

- Manganese (Mn): The CDPHE manganese standard for secondary drinking water is 0.05 mg/l and for agricultural water it is 0.2 mg/l. Manganese rusts like iron but it is not magnetic.

Manganese was not detected in the recent water sample from your new well.

Manganese was not detected in the 3/31/06 water sample from your new well.

- Fluoride (F): The CDPHE fluoride standard for human drinking water is 4.0 mg/l and for agricultural water it is 2.0 mg/l.

Fluoride was detected in the recent water sample collected from your new well at a concentration of 1.9 mg/l which is within the human drinking water standard and within the agricultural standard.

Fluoride was detected in the 3/31/06 water sample collected from your new well at a concentration of 1.9 mg/l which is within the human drinking water standard and within the agricultural standard.

- Calcium (Ca), Potassium (K), Magnesium (Mg), Bicarbonate ( $\text{HCO}_3$ ) and Carbonate ( $\text{CO}_3$ ) were also tested for in your new well water. There are no standards from CDPHE for these parameters.

**If your water exceeded any of the CDPHE standards for human drinking water, and if you or your livestock and pets drink your water, then you may wish to discuss the possible health effects of continued consumption with your physician and/or veterinarian. In addition, it may be prudent for you to consider treating your water prior to consumption. Information is being provided to you that contain procedures recommended by the EPA.**

#### **METHANE GAS CONCENTRATION**

Dissolved methane was detected in the recent sample from your new well at a concentration of 2.8 mg/l. This value is slightly above the theoretical threshold of 2 mg/l that could allow methane to accumulate to potentially explosive levels in unventilated areas.

Dissolved methane was detected in the 3/31/06 sample from your new well at a concentration of 5.6 mg/l. This value is above the theoretical threshold of 2 mg/l that could allow methane to accumulate to potentially explosive levels in unventilated areas.

Methane alone is physiologically inert and non-toxic to humans. The presence of methane in drinking water does not present a known health hazard to humans or other animals by ingestion. Methane gas dissolved in water "exsolves" when exposed to the atmosphere and dissipates rapidly because it is lighter than air. If the methane occurs at a high enough concentration and if it is allowed to accumulate in a confined space, such as a well pit, crawl space, closet, etc., then an explosion hazard could exist.

### COMPARISON OF ORGANIC ANALYTICAL RESULTS TO STANDARDS

**Benzene:** The CDPHE basic ground water standard for benzene is 5 ug/l. Benzene was not detected in either water sample from your new well.

**Toluene:** The CDPHE basic ground water standard for toluene is 1,000 ug/l. Toluene was not detected in either water sample your new well.

**Ethylbenzene:** The CDPHE basic ground water standard for ethylbenzene is 680 ug/l. Ethylbenzene was not detected in either water sample your new well.

**Xylene:** The CDPHE basic ground water standard for xylene is 10,000 ug/l. Xylene was not detected in either water sample from your new well.

### BIOLOGICAL ACTIVITY REACTION TEST (BART) RESULTS

Additionally, water samples were also collected to conduct in-house Biological Activity Reaction Tests (BART) for iron-related bacteria (IRB), sulfate-reducing bacteria (SRB), and slime-forming bacteria (SYLM). Please note that these are not quantitative tests and are provided only to indicate the probable bacterial population (see attached photos). After three weeks of observation, results are as follows:

**Iron Related Bacteria:** Although not usually harmful, iron related bacteria (IRB) can become a nuisance by plugging well pumps, causing red staining on plumbing fixtures and laundered

clothing, building up red, slimy accumulations on any surface the water touches, causing what appears to be an oily sheen on standing water. In rare cases, IRB may cause sickness.

- **There are deep seated anaerobic flora with pseudomonads and IRB present in your water well.**

**Sulfate Reducing Bacteria:** Sulfate reducing bacteria (SRB) are serious nuisance organisms in water since they can cause severe taste and odor problems. These bacteria reduce sulfate ( $\text{SO}_4$ ) that occurs naturally in the water and generate hydrogen sulfide ( $\text{H}_2\text{S}$ ) gas as they grow. In turn, the hydrogen sulfide ( $\text{H}_2\text{S}$ ) gas is a nuisance because it smells like rotten eggs, it initiates corrosion on metal surfaces, and it reacts with dissolved metals such as iron to generate black sulfide deposits.

- **A diverse SRB community is present in your water well.**

**Slime-Forming Bacteria:** Slime-forming bacteria (SLYM) are able to produce copious amounts of slime without necessarily having to use any iron. Iron bacteria also produce slime but it is usually thinner and involves the accumulation of various forms of iron. These bacteria generally produce the thickest slime formations under aerobic (oxidative) conditions.

- **Dense slime formers with aerobic bacteria are present in your water well.**

### EVALUATION OF GAS ANALYTICAL RESULTS

The gas produced from the oil/gas wells around your home is "thermogenic" methane. Thermogenic methane gas is formed by the thermal breakdown of organic material in rocks



resulting from high temperatures created by deep burial. Biogenic methane gas occurs in most near-surface environments and is a principal product of the decomposition of buried organic material. In Weld County many of the coal zones in the Laramie/Fox Hills aquifer contain biogenic methane gas.

Laboratory results of the gas sample collected from your water well indicated that methane (C1) and ethane (C2) were detected. Typically, the naturally occurring biogenic gas in the Laramie/Fox Hills aquifer contains only methane and ethane. The presence of propane (C3), iso-butane (iC4), normal butane (nC4), iso-pentane (iC5), normal pentane (nC5), and hexane (C6) would indicate a potential impact from thermogenic gas originating from deeper gas producing formations.

COGCC records indicate that within a ½ mile radius of your water well there are currently thirty (30) producing oil/gas wells, one (1) temporarily abandoned oil/gas well, one (1) plugged and abandoned oil/gas well, and three (3) permitted or recently drilled oil/gas well. Of the producing wells, there are six (6) completion types: J Sand, Codell, J/Codell, Niobrara/Codell, Sussex, and Niobrara/Codell/Sussex.

A chart containing the gas compositional analytical results of the recent sample from your water well and selected oil/gas wells is attached (Exhibit 1). The chart shows the variations in different gas compositions. The composition of the methane gas in your water well is not similar to the gas produced from nearby oil/gas wells.

#### **DATA EVALUATION OF ANALYTICAL RESULTS**

COGCC files contain analytical data of the produced water from the J Sand, Niobrara/Codell, and Sussex. Analytical datum of typical frac fluid is also presented. Analytical data from both of your water wells, selected oil/gas wells, and frac fluid was entered into HydroChem, a RockWare earth science computer software program. Data can then be plotted on Stiff diagrams or Piper diagrams, two types of visual presentations.

##### **Moorehead Water Wells**

The Stiff diagrams of the laboratory data clearly shows the difference between the cation/anion signatures of your new water well and the former water well sampled in 2005 (Exhibit 2).

The Piper diagram displays data on a tri-linear chart. Total Dissolved Solids (TDS) values for each datum are indicated by circles; the greater the TDS, the larger the diameter of the circle. The Piper diagram of the laboratory data shows that the recent sample from your new water well plots away from your former well (Exhibit 3).

##### **Moorehead Water Wells vs. Produced Waters / Frac Fluid**

The Stiff diagrams of the laboratory data clearly show the differences between the cation/anion signature of the samples from your new water well and the cation/anion signature of the produced waters and frac fluid (Exhibit 4).

The Piper diagram displays data on a tri-linear chart. Total Dissolved Solids (TDS) values for each datum are indicated by circles; the greater the TDS, the larger the diameter of the circle. The Piper diagram clearly shows that the produced water and frac fluid data plot in close proximity on

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the chart. The datum from the recent sample from your new water well plots away from the produced waters and frac fluid data. The Piper diagram also shows that the recent sample from your new water well has a much lower TDS concentration than the produced waters and frac fluid (Exhibit 5).

#### **SUMMARY AND CONCLUSIONS**

The water quality in your new well as sampled on two occasions in 2006 is much better than the water quality in your former water well that was sampled in 2005. Additionally, there is no appreciable difference between the water quality in your new well between the two sampling dates of 3/31/06 and 10/17/06.

Based on available information, the water in your recently drilled well does not appear to have been impacted by nearby oil/gas operations. Therefore, this complaint is resolved and no additional action or investigation will be conducted at this time.

Should you have any questions, please call me at (303) 894-2100 ext. 118.

Sincerely,

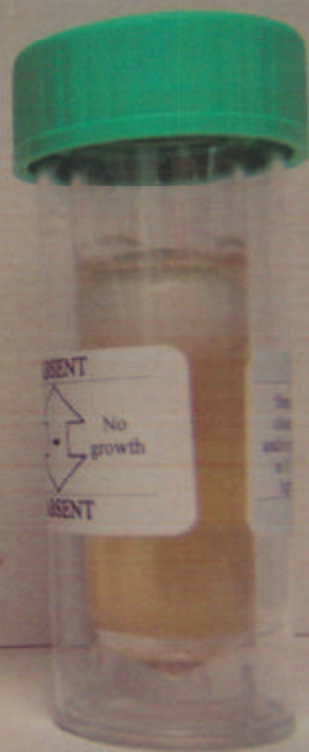
A handwritten signature in black ink, appearing to read "Randall H. Ferguson", followed by a horizontal line.

Randall H. Ferguson  
Environmental Protection Specialist

#### **Attachments**

Cc: Brian Macke – COGCC Director  
Debbie Baldwin – COGCC Environmental Manager

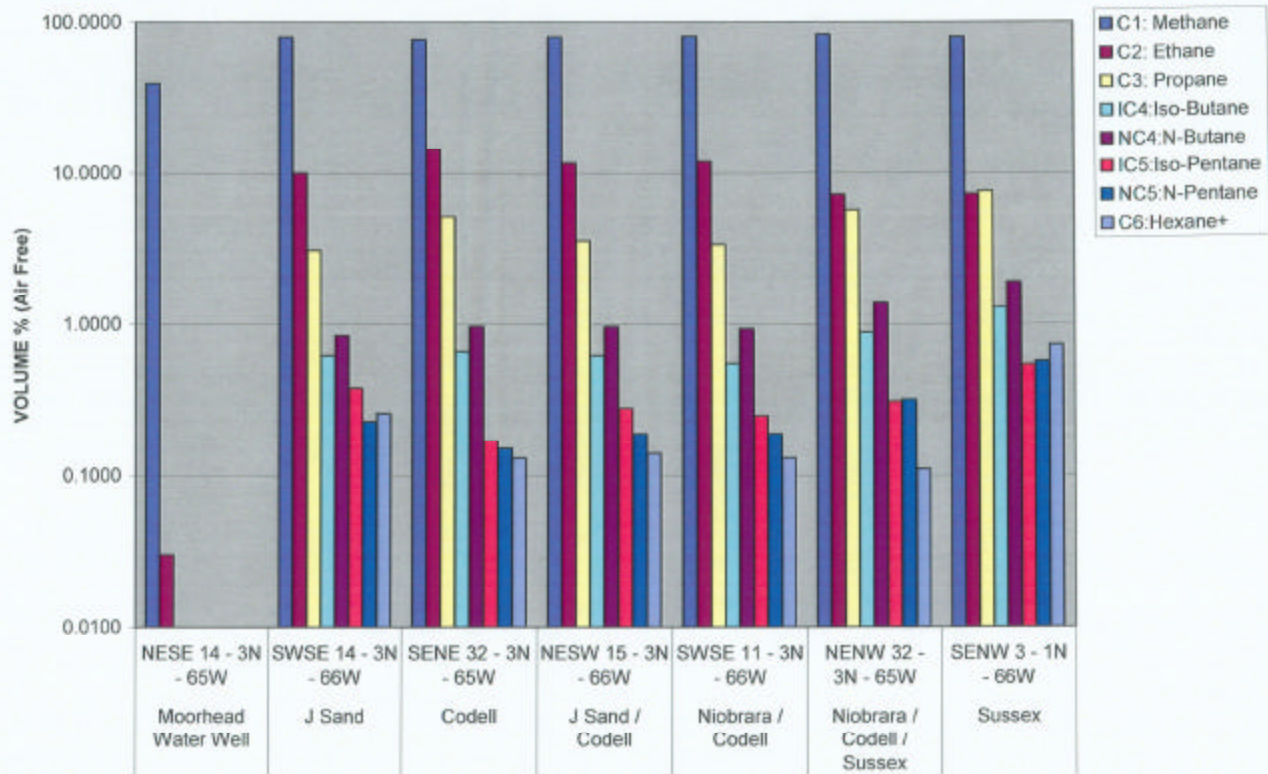




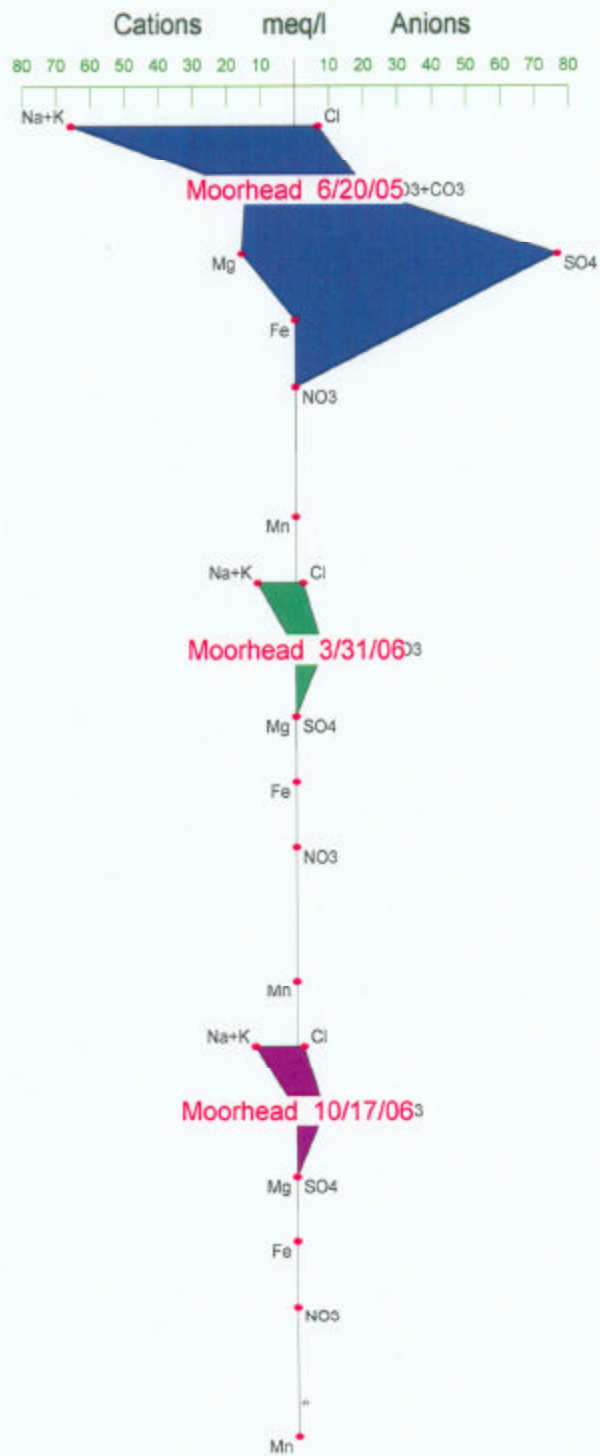




# MOORHEAD WATER WELL GAS / THERMOGENIC GASES

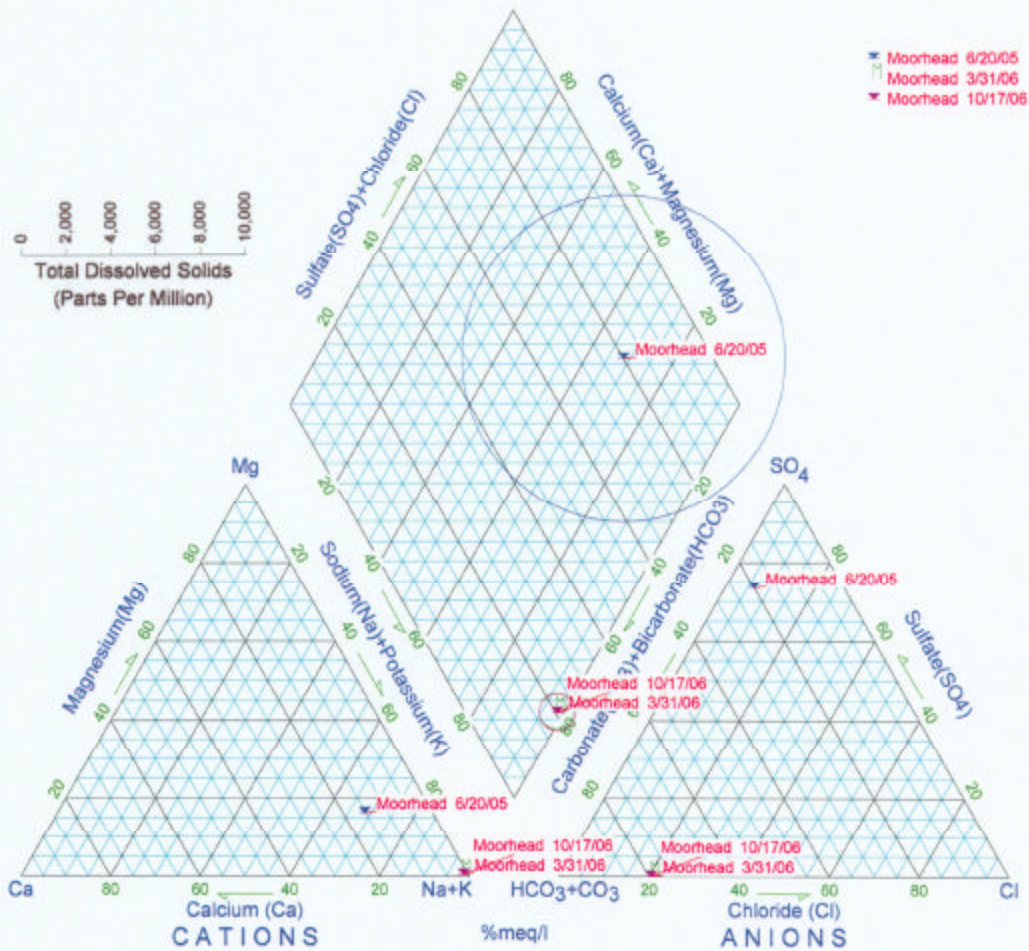


# MOORHEAD WATER WELL COMPLAINT

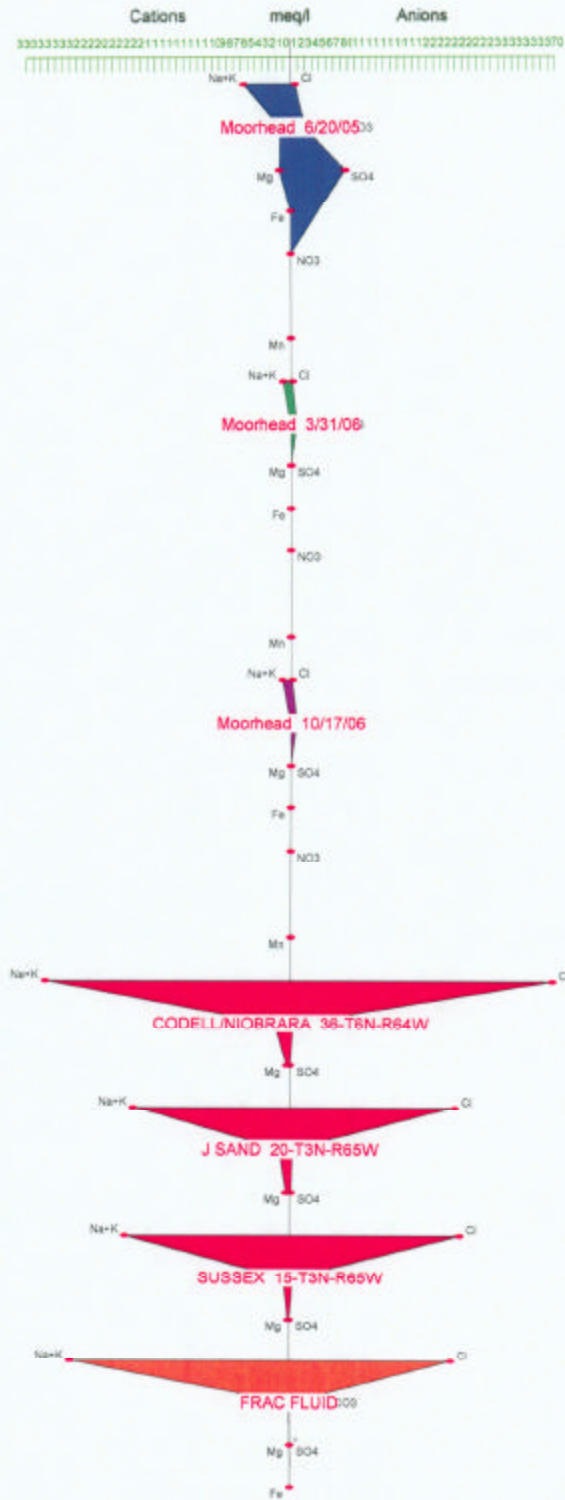




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