Improving Reclamation on Oil and Gas Well Pads in the Rocky Mountain West

IPAMS 2008 ROCKY MOUNTAIN ENERGY TECHNOLOGY CONFERENCE

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MWH

Reclamation Science—The State of the Art

- The knowledge base for the reclamation of disturbed lands in the western U.S. is extensive
  - Reseeding of millions of acres following the dust bowl of the 1930s
  - Improvements of millions of acres of arid and semiarid rangelands in the 1960s—1980s following more than a half a century of rangeland exploitation

Reclamation Science—The State of the Art

- Conversion of millions of acres of marginal farm land to perennial grasslands under the USDA Conservation Reserve Program beginning in 1985

- Reclamation of tens of thousands of acres of mined lands, especially following SMCRA and rigorous state rules and regulations governing mine land reclamation

Reclamation Science—The State of the Art

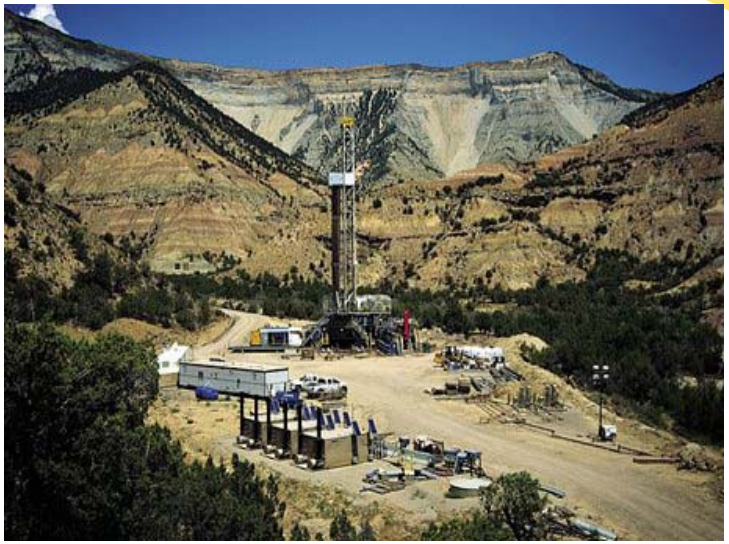
- Relevance to Oil and Gas Reclamation
    - The knowledge that has been accumulated from decades of reclamation work in the western U.S. has direct application to the O&G industry
    - No need to reinvent the wheel for O&G reclamation

Reclamation Science—The State of the Art

- Relevance to Oil and Gas Reclamation (continued)
  - Although some of the knowledge is being applied to O&G, much of it is not being used
  - The effectiveness of achieving reclamation success needs to increase if O&G development is going to be allowed to continue

Environmental Challenges to Reclamation Success

Physical Challenges



- Extremes in Texture
  - Infiltration
  - Water holding capacity
  - Cation exchange capacity
- Soil Compaction
  - Too much compaction results in the loss of macropores, runoff increases, potential for erosion increases, and root growth is restricted.

Environmental Challenges to Reclamation Success

Physical Challenges (continued)

- Rock Fragments
  - Reduction in root volume
  - Decline in TWH capacity
  - Reduction in total soil nutrients
  - Elevated surface temperature (higher heat capacity than soil)
  - Poor seed soil contact in seedbed

Environmental Challenges to Reclamation Success

Physical Challenges (continued)

- Erosion
  - Major limiting factor to restoration success
  - Water (sheet and rill/gully)
  - Wind

Environmental Challenges to Reclamation Success

Physical Challenges (continued)

- Precipitation
  - Arid and semi-arid conditions are a limiting factor for plant establishment
  - In below average precipitation years, rainfall may result in successful germination, but overall precipitation may not be adequate to support long-term establishment

Environmental Challenges to Reclamation Success

Chemical Challenges

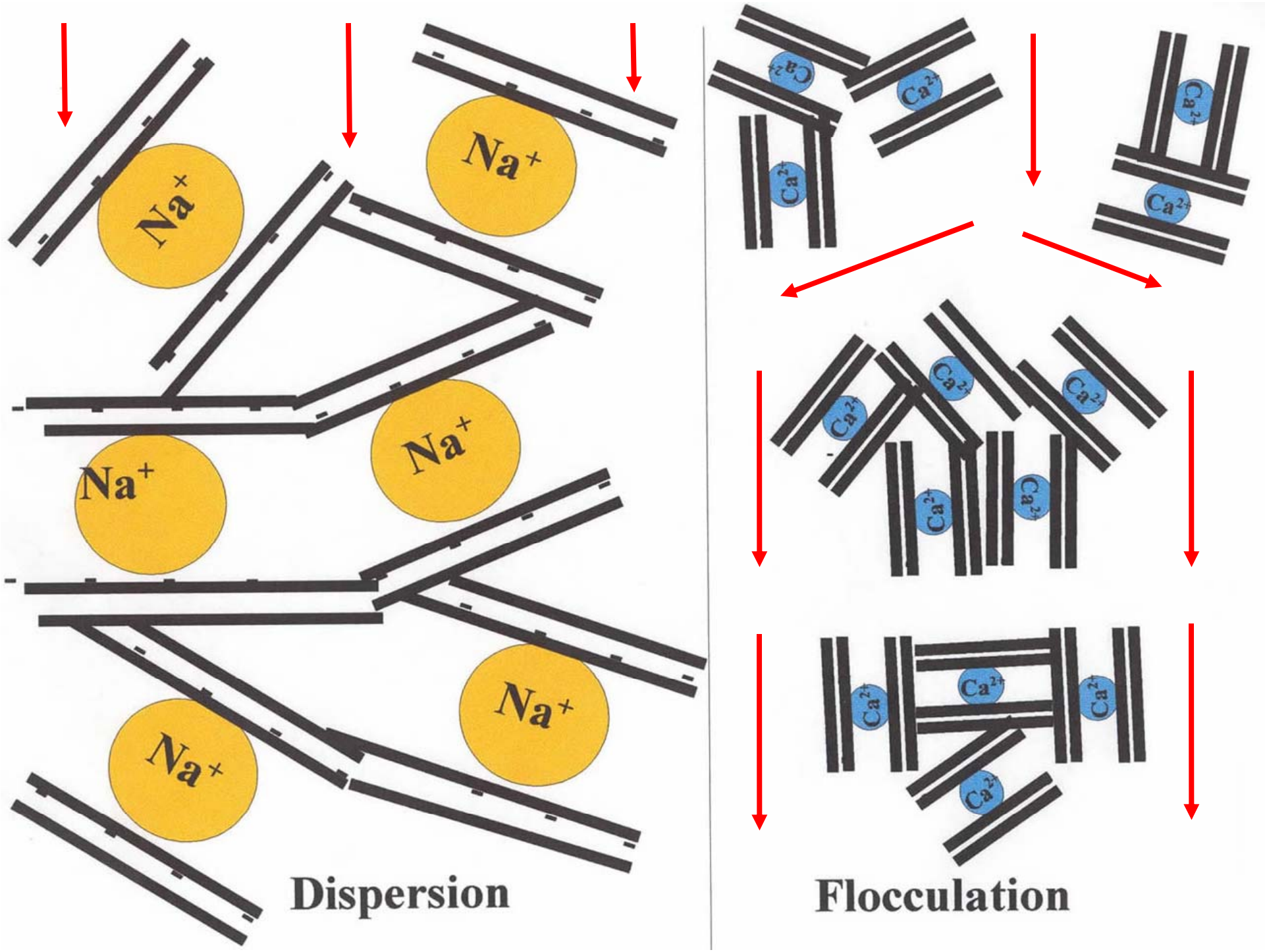
- Soil pH
    - Extremes in pH are problematic for plant growth (<5.0 or >9.0)

- Soil salinity (EC > 4 mmhos/cm)
    - Effects plant's ability to take up water
    - Effect is more prevalent during germination and early seedling growth

Environmental Challenges to Reclamation Success

Chemical Challenges (continued)

- Soil sodicity
    - Deterioration of soil structure (defloculation or dispersion of soil particles) results in restricted water movement into soil


Na+
Na+
Na+
Na+
Na+
Na+
Dispersion
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Flocculation

Environmental Challenges to Reclamation Success

Biological Challenges

- Invasive Species
    - Competition from highly competition invasive plants (noxious and non-noxious weeds)
- Grazing Animals
    - Over utilization by wildlife and domestic livestock

Other Challenges to Reclamation Success

Improper Reclamation Techniques

- Inadequate seedbed preparation
- Lack of “safe sites” for seed germination & establishment
- Seed distribution not uniform
- Planting seed too deep
- Seeding rates too low
- Seeding wrong time of the year

Other Challenges to Reclamation Success

Improper Species Selection and Seed Mixture Composition

- Species or cultivars not adapted to site conditions
- Use of species that have seed dormancy issues
- Use of species that are difficult to establish or very slow growing
- Formulating seed mixtures that over emphasize species that are difficult to establish or are highly aggressive

Overcoming Challenges for Reclamation Success

- Eliminate soil compaction by ripping or scarifying
- If rock fragments are high, then considering adding amendments to increase WHC
- Control erosion with mulch or reduce slope angle and length
- Cover saline soils or use only salt tolerant species
- Cover sodic soils, use only sodium tolerant species, or treat with gypsum
- Control invasive species

Overcoming Challenges for Reclamation Success

- Use of fencing to exclude large herbivores
- Rough seedbed is superior to a smooth seedbed
- Implement quality controls during seeding
- Seed prior to the period of greatest precipitation or period of most reliable precipitation (this varies by region)
- Select species and cultivars that are adapted to site conditions (soil type, elevation, precipitation).
- If seed supplies are coming from native collections, only use seed to that has been collected from environments similar to where planting will occur

Overcoming Challenges for Reclamation Success

- Minimize the use of slow growing species
- Minimize the use of species with seed dormancy issues
- Formulate seed mixtures based on the ecological characteristics of the species
- Implement monitoring programs to measure reclamation success