Geology: North Idaho and Montana IFTNC Nutrition Guidelines Update

Good Rocks-Bad Rocks

- Geology: A contributor to forest nutrition and health (mid-1990's)
- Regional geology mapping and nutritional assessment: "Relative" nutritional value of various rock types
- Geology/nutrition guidelines for various regions

Regional Geology Guidelines

- 2001: North Idaho
- 2004: Washington (both regions)
- 2006: Western Montana (preliminary)
- 2007: North Idaho (revised) and Western Montana (revised)

What makes a rock ‘good’ or ‘bad’?

- Weathering susceptibility: Weathering *potential* combined with conditions conducive to chemical weathering
- Tree-growing rating: A combination of expected weathering susceptibility, rock nutritive value and observed forest productivity conditions; ‘blanket’ rating assumes gentle slopes and no surficial materials
- Slope: Steeper slopes reduce rock rating
- Surficial materials: Includes ash, loess, saprolite. Value of surficial materials is often in the moisture-holding capacity; increase rock rating

Site Moisture Conditions

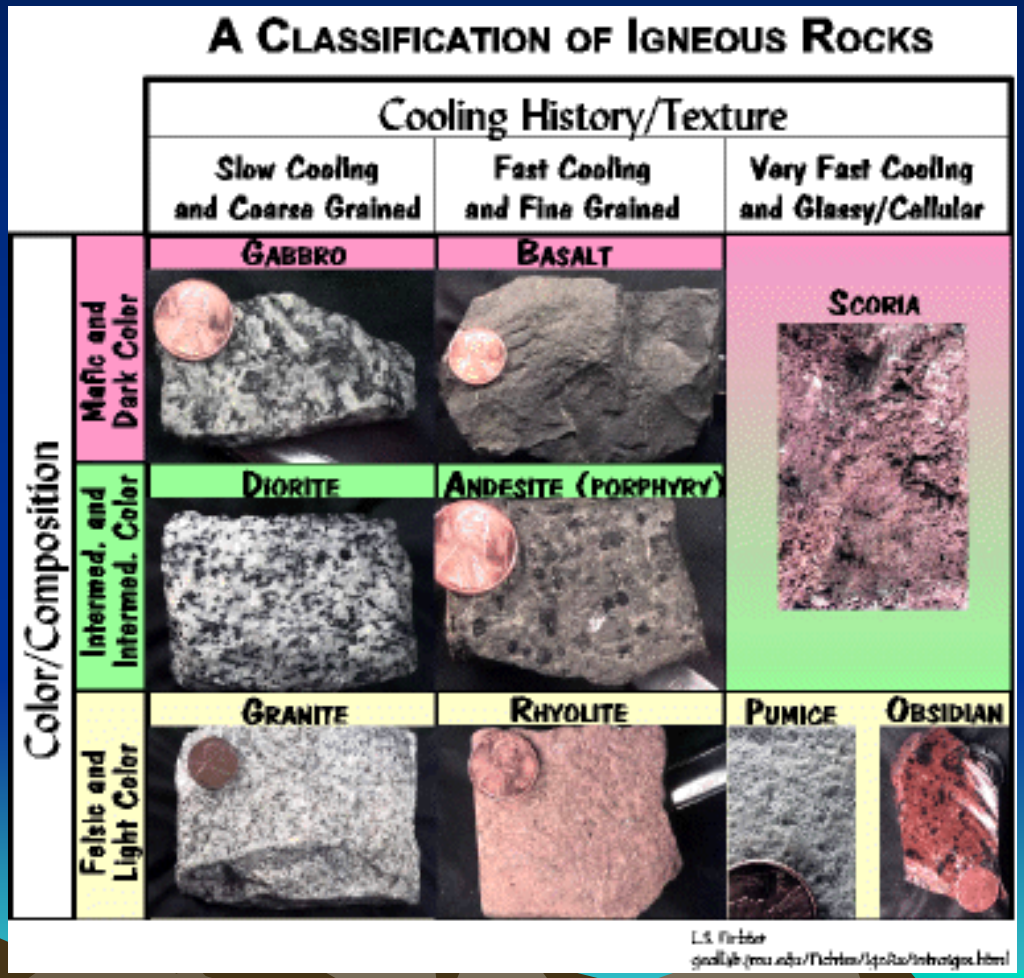
- ‘Blanket’ ratings do not take climatic or moisture conditions into account.
- Favorable moisture conditions are associated with greater productivity.
  - Using vegetation series as a proxy of site moisture conditions: WRC>GF>DF
  - OR use ash cap presence & depth: 7+ inches is better than <7 inches (though additional ash after 7 inches doesn’t seem to have an effect)

Nutrition/Geology Guidelines

Categorization of lots of rock units into a few categories:

1. Extrusive & sub-volcanic rocks (Formerly Extrusives/Basalts)
2. Intrusive rocks (Formerly Intrusives/Granites)
3. Metamorphic rocks (Formerly Metmorphic Rocks)
4. Sedimentary rocks (formerly Mixed Rocks)
5. Unconsolidated deposits (formerly Mixed Rocks)

Igneous Rock Classification



Extrusive & Subvolcanic Rocks

- Felsic volcanic/subvolcanic rocks
  - Lighter-colored rocks (rhyolite, dacite)
  - Medium weathering susceptibility
  - Bad rocks
- Mafic volcanic/subvolcanic rocks
  - Darker-colored rocks (basalt, andesite)
  - High weathering susceptibility
  - Good (basalt) to bad (andesite, dikes) rocks
    - Is this a topography issue?

Intrusive Rocks

- Felsic intrusive rocks (formerly ‘light’ granites)
  - Granite, quartz monzonite, granodiorite, tonalite
  - Medium weathering susceptibility
  - Medium (most) to bad (syenite, pegmatite, dikes) rocks
- Mafic intrusive rocks (formerly ‘dark’ granites)
  - Quartz diorite, diorite, gabbro
  - High weathering susceptibility
  - Medium (most) to bad (gabbro, diabase, dikes) rocks

Metamorphic Rocks: The Good
High weathering, Good Rocks

- Calc-silicate rocks
  - Metamorphosed carbonate-bearing metasedimentary & sedimentary rocks
  - Mostly gneisses & schists
  - High weathering rate, good rocks
- Carbonate-bearing metasedimentary rocks
  - The less-metamorphosed version of the above.
  - Dolomitic siltite, argillite w/carbonate, etc.
  - High weathering rate, good rocks

Metamorphic Rocks: The Medium
Medium weathering, Medium rocks

- Metamorphosed felsic intrusive rocks
  - Orthogneiss, augen gneiss, biotite tonalite gneiss
- Some metamorphosed mafic intrusive rocks
  - Quartz diorite gneiss
- Schist-gneiss
  - Biotite, mica schists & gneisses, non-calc-silicate Belt metasedimentary rocks
- Siltite-argillite
  - Mostly non-carbonate-bearing Belt metasedimentary rocks
- Some feldspathic quartzites
  - Micaceous and feldspathic quartzites

Metamorphic Rocks: The Bad
Variable weathering, Bad rocks

- Some metamorphosed mafic intrusive rocks
  - Amphibolite. Medium weathering susceptibility. Bad rock.
- Quartzite
  - Mostly sand. Very low weathering susceptibility. Very bad rocks.
- Some feldspathic quartzites
  - The ‘clean’ version – mostly sand. Low weathering susceptibility. Bad rocks.
- Carbonate rocks
  - Metamorphosed or intermixed limestone, dolomite. Medium weathering susceptibility. Bad rocks.
- Greenstone
  - Chlorite-bearing, some meta-volcanics. High weathering susceptibility. Bad rocks.
- Ultramafic rocks
  - High weathering susceptibility. Bad rocks.

Sedimentary Rocks

- Feldspathic sandstone
  - Medium weathering susceptibility
  - Good rocks
- Carbonate-bearing sedimentary rocks
  - High weathering susceptibility
  - Good rocks
- Mudstone
  - Medium weathering susceptibility
  - Medium rocks
- Carbonate Rocks
  - Medium weathering susceptibility
  - Bad rocks
- Conglomerate Rocks
  - Low weathering susceptibility
  - Bad rocks

Unconsolidated Deposits

- Glacial deposits
  - Low weathering susceptibility. Variable to bad rocks.
- Lake deposits
  - Medium weathering susceptibility. Variable to bad rocks.
- Stream deposits
  - Low weathering susceptibility. Variable to medium rocks.
- Older sediments
  - Medium weathering susceptibility. Variable rocks (what's the source?)
- Landslide deposits
  - Medium weathering susceptibility. Variable to good rocks (what's the source? What's the topography?)

Nutrition Guidelines

- Cultural Operations
  - Harvest operations (intermediate, regeneration)
    - Whole-tree removal
    - Bole-only removal
  - Species selection
- Fertilization (using vegetation series as proxy for site moisture conditions)
  - WRC, WH (best)
  - GF (next best)
  - DF (lowest priority)
  - PP or drier (don’t fertilize)

Species Nutrient Demand

• Grand fir	Very high
• Douglas-fir	High
• White pine	Moderate to high
• Ponderosa pine	Moderate
• Lodgepole pine	Low
• Western larch	Low
• Western hemlock	Low (?)

Geology Guidelines: Good Rocks

- Good candidates for fertilization
  - Nitrogen-only may be OK, however trees may also respond to S and B
  - Good multinutrient candidates
  - Fertilize grand fir or moister vegetation series
- Use conservative nutrient management strategies, but these sites may be more resilient to more extreme strategies such as whole-tree removal
- Most species will do well on these sites

Geology Guidelines: Medium Rocks

- Fertilization only on moist sites
  - N+K generally recommended, S and B may also be useful
  - Good multinutrient candidate sites
- Conservative nutrient management strategies recommended
  - Bole-only recommended for thinning, but whole-tree may be OK
  - Bole-only recommended for regeneration harvest
- Select for low to moderate nutrient demanding species

Geology Guidelines: Bad Rocks

- Fertilization not recommended
- Conservative nutrient management should be followed
  - Bole-only generally recommended, though whole-tree may be fine for thinning from below or other light thinnings
- Select for low nutrient-demanding species

Thank You!

Montana Agricultural Experiment Station

MSU, Bozeman

Geologic Parent Materials of Montana Soils (Bulletin 721, 1980)

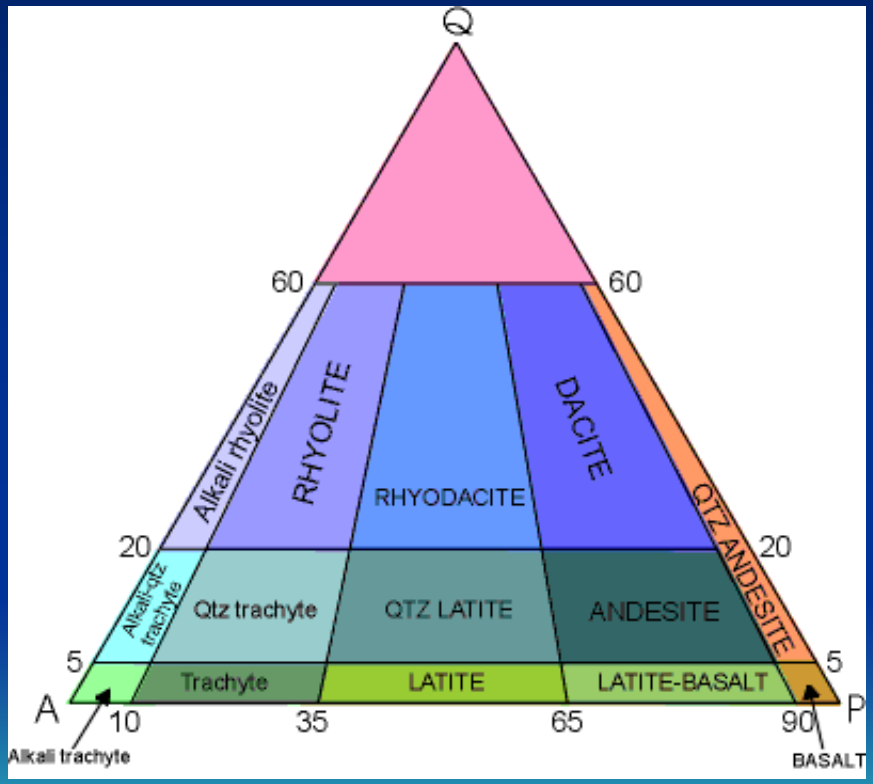
Soils of Montana (Bulletin 744, 1982)

Overlying Materials or Weathered Surfaces

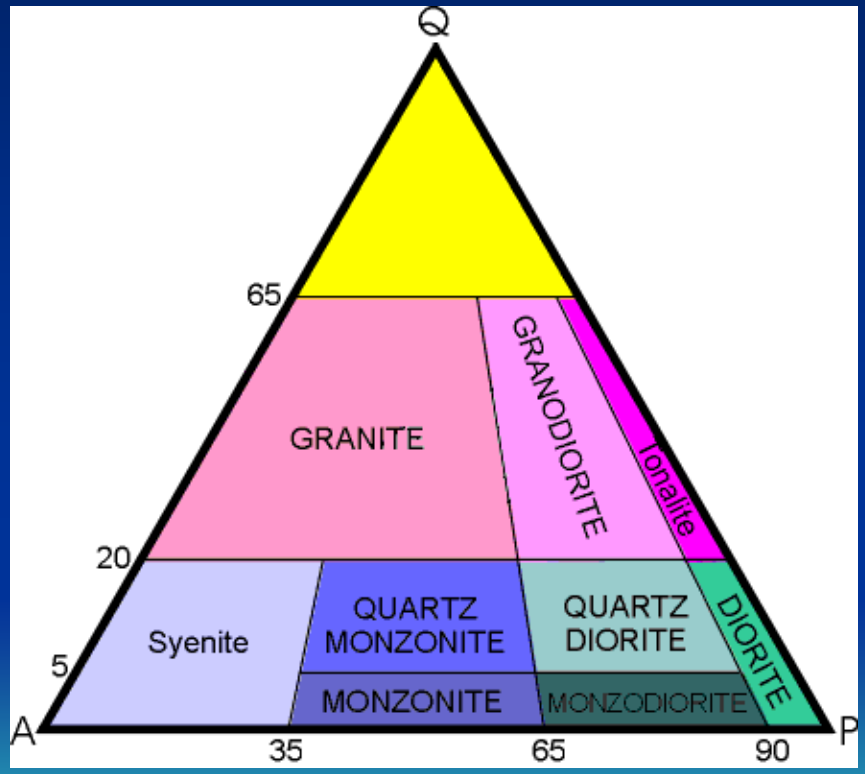
- Shown as overlays (hatchmarks) on current north Idaho geology maps
- Loess
  - Low weathering susceptibility (previously weathered material)
  - Medium tree value
- Saprolite
  - Rocks that have weathered in place
  - Low weathering susceptility
  - Medium tree value

Igneous Rocks

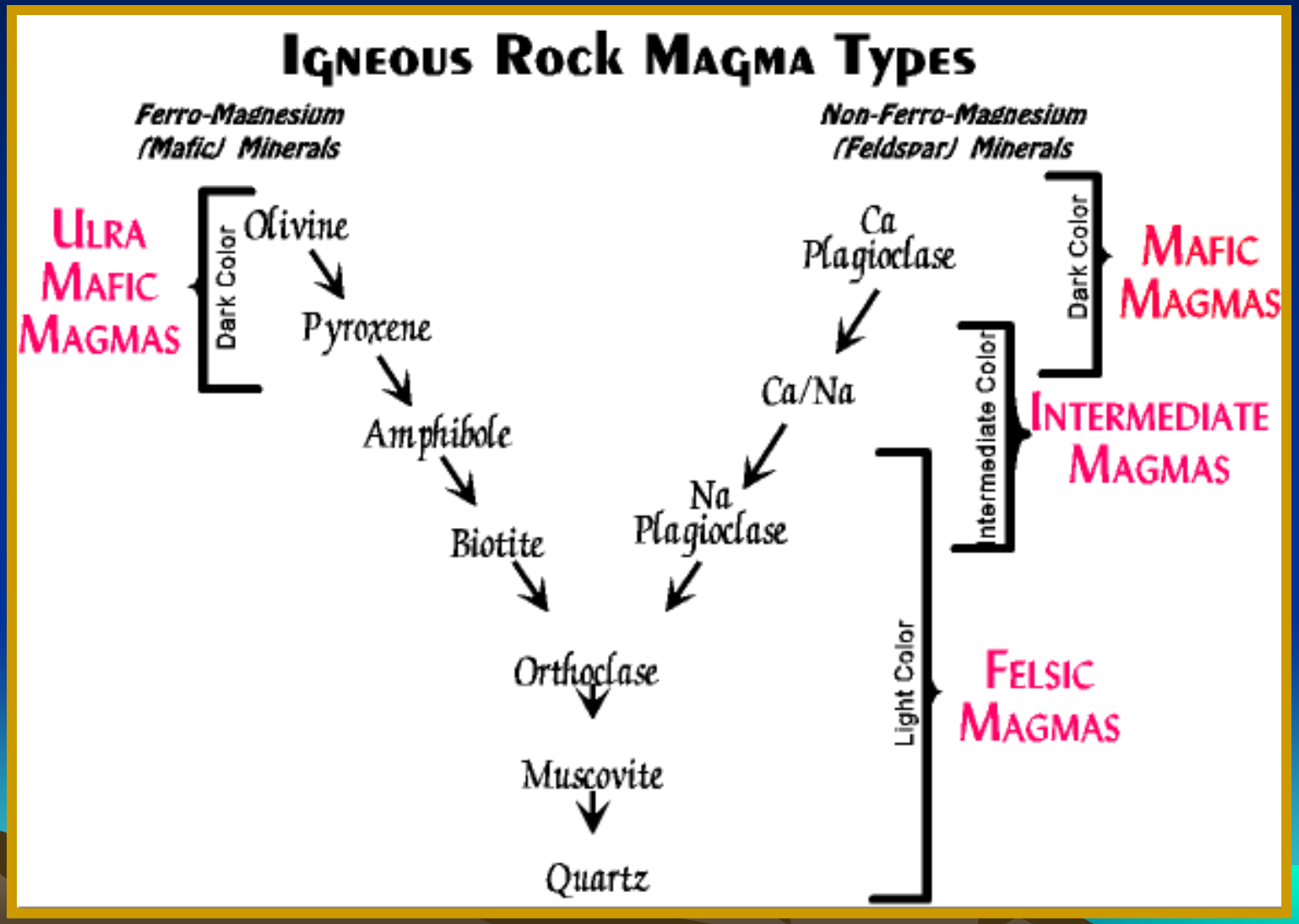
Intrusive Rocks



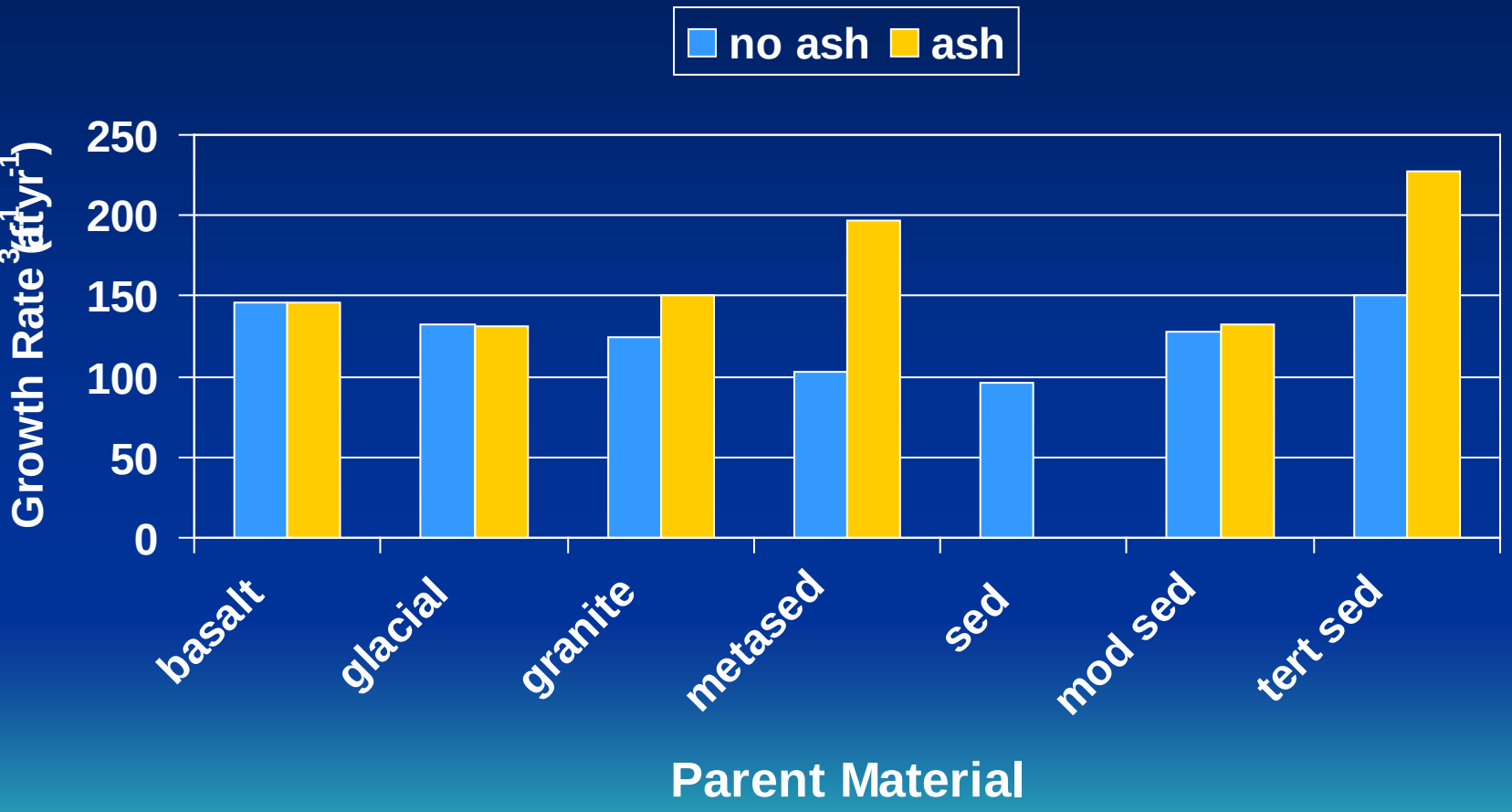
Extrusive & Subvolcanic Rocks



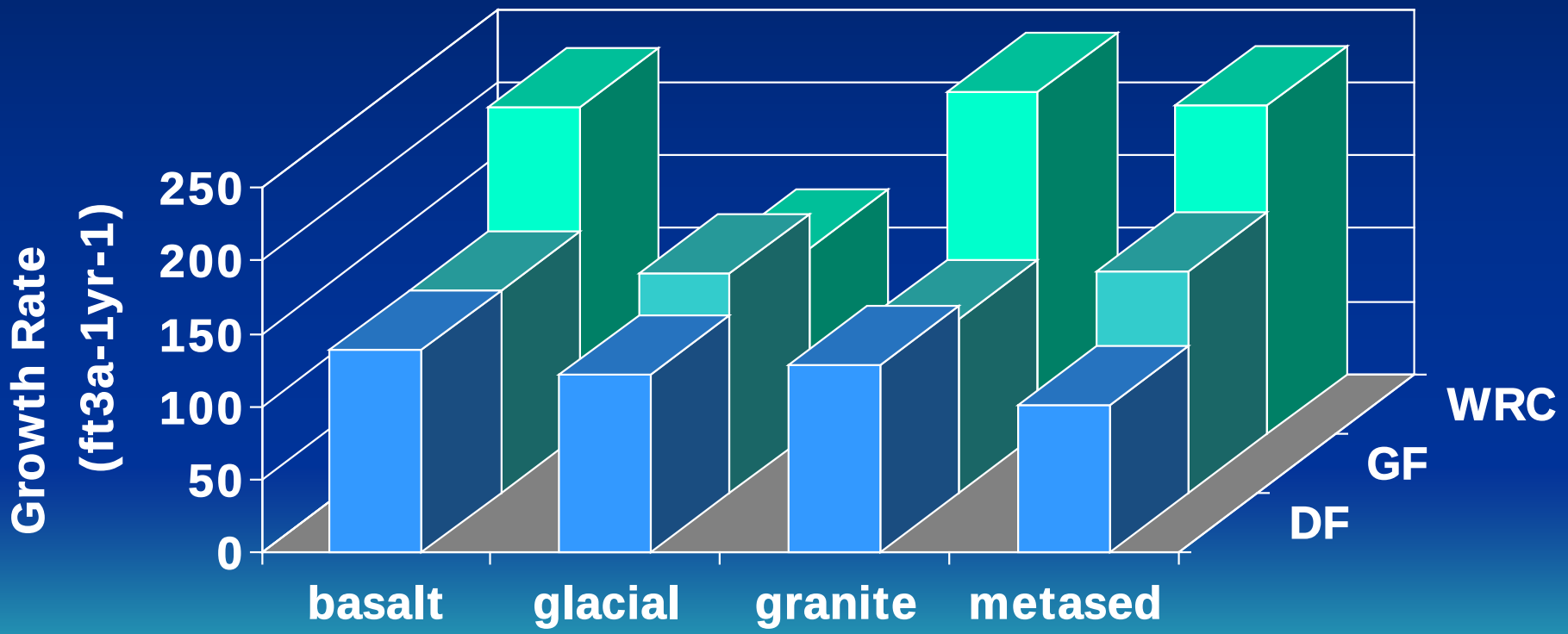
Bouwen's Reaction Series



Growth Rate vs Ash Cap Presence



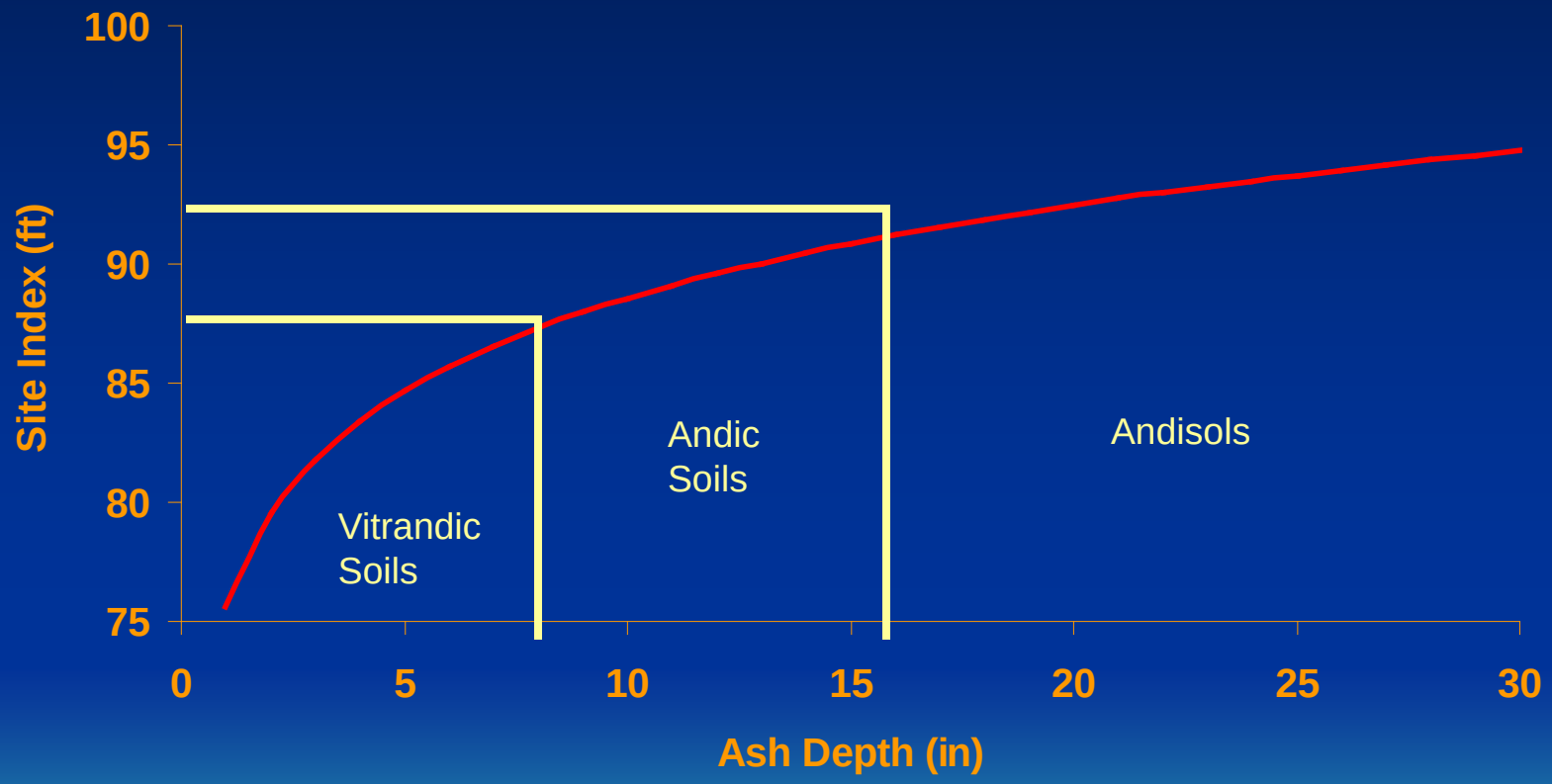
Growth Rate by Vegetation Series and Parent Material



What about surficial deposits?

- We know more about ash than other surficial deposits due to the number of sites we have with ash
- “Conventional wisdom” suggests P and S (and likely other anions such as nitrate) may be adsorbed and held unavailable by ash-influenced soils
- Agenda 2020 Project (Phase I) review of soil and foliar nutrition characteristics of IFTNC research sites showed:
  - B: With increasing ash depth we saw increased soil availability and increased foliage concentration
  - P, K, N: No effect of ash presence or depth on soil availability or foliage concentrations
  - Mg, Ca: With increasing ash depth we saw decreased soil availability and decreased foliage concentration

Ash and DF Site Index



Kimsey, 2006

Potential Available Water (Upper 24”) vs Ash Depth