# Four Soil Orders on a Vermont mountaintop – One-third of the world's soil orders in a 2500 square meter research plot

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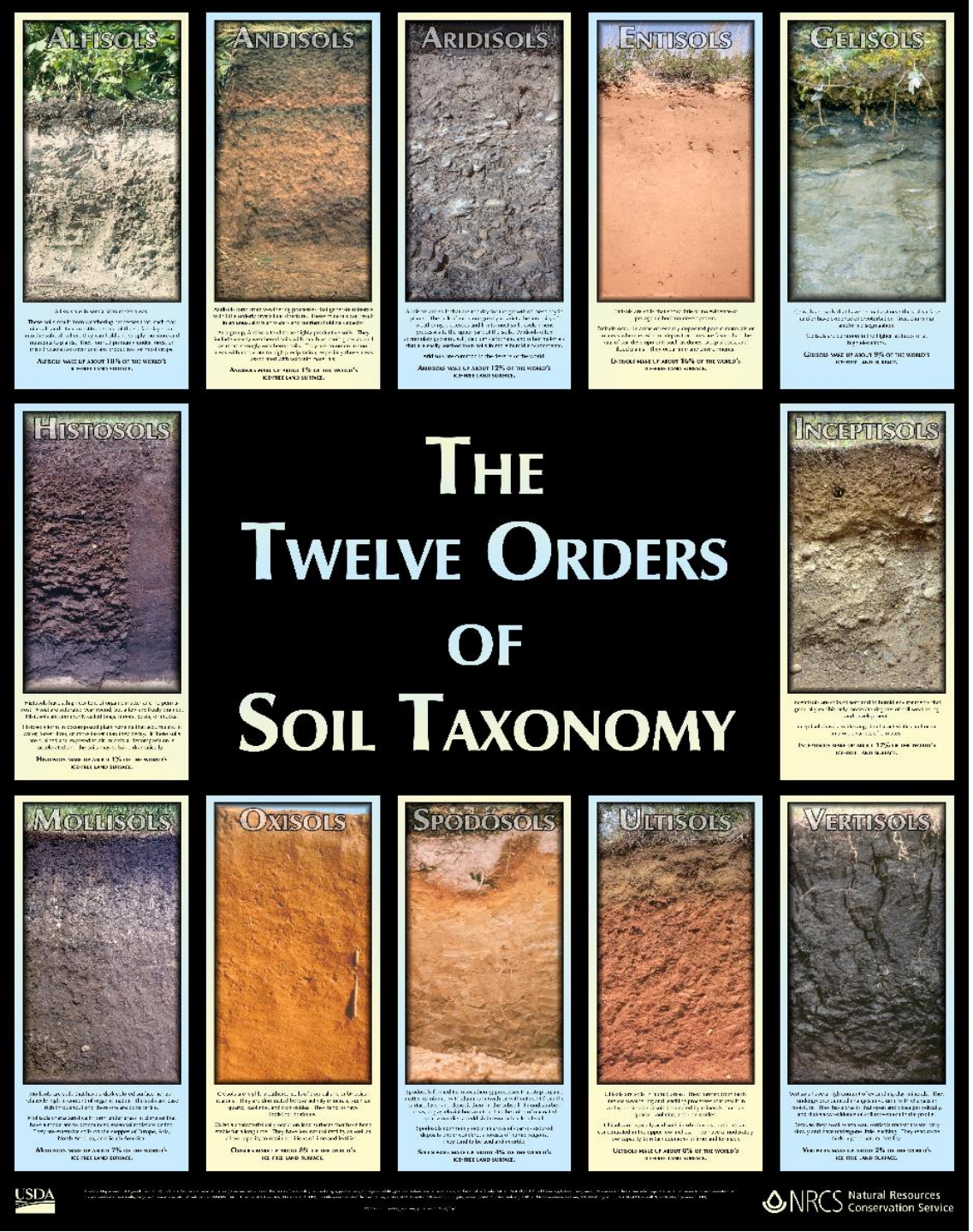
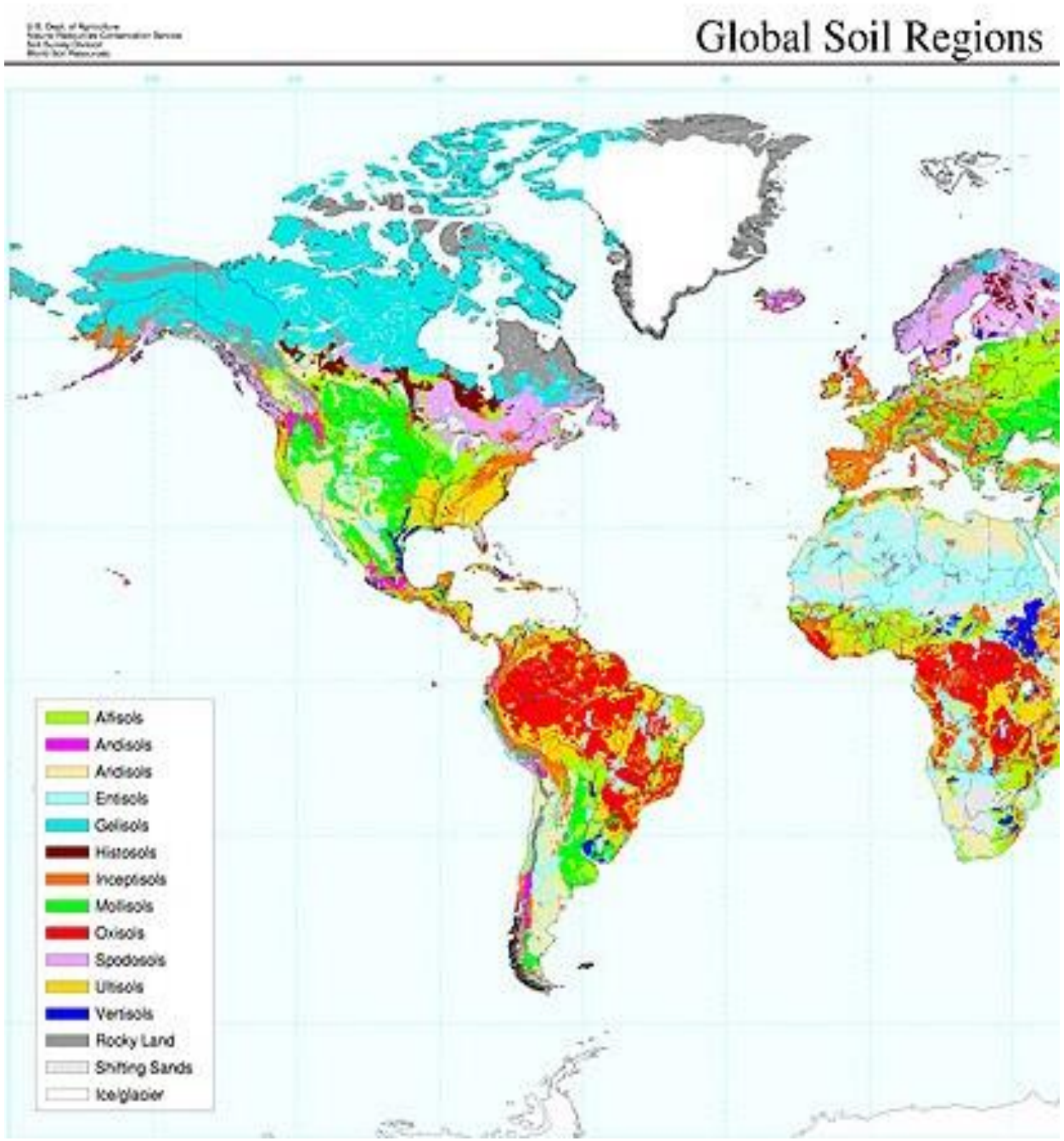

Alfisols
Andisols
Aridisols
Entisols
Gelisols
Histosols
Inceptisols
Mollisols
Oxisols
Spodosols
Ultisols
Vertisols
The Twelve Orders of Soil Taxonomy
USDA
NRCS Natural Resources Conservation Service


Global Soil Regions
Alfisols
Andisols
Aridisols
Entisols
Gelisols
Histosols
Inceptisols
Mollisols
Oxisols
Spodosols
Ultisols
Vertisols
Rocky Land
Shifting Sands
Ice/glacier

38% of world's soils are in these 4 soil Orders


Entisols are soils that show little or no evidence of pedogenic horizon development.

Entisols occur in areas of recently deposited parent materials or in areas where erosion or deposition rates are faster than the rate of soil development; such as dunes, steep slopes, and flood plains. They occur in many environments.

**ENTISOLS MAKE UP ABOUT 16% OF THE WORLD'S ICE-FREE LAND SURFACE.**


Histosols have a high content of organic matter and no permafrost. Most are saturated year round, but a few are freely drained. Histosols are commonly called bogs, moors, peats, or mucks.

Histosols form in decomposed plant remains that accumulate in water, forest litter, or moss faster than they decay. If these soils are drained and exposed to air, microbial decomposition is accelerated and the soils may subside dramatically.

**HISTOSOLS MAKE UP ABOUT 1% OF THE WORLD'S ICE-FREE LAND SURFACE.**


Inceptisols are soils of semiarid to humid environments that generally exhibit only moderate degrees of soil weathering and development.

Inceptisols have a wide range in characteristics and occur in a wide variety of climates.

**INCEPTISOLS MAKE UP ABOUT 17% OF THE WORLD'S ICE-FREE LAND SURFACE.**


Spodosols formed from weathering processes that strip organic matter combined with aluminum (with or without iron) from the surface layer and deposit them in the subsoil. In undisturbed areas, a gray eluvial horizon that has the color of uncoated quartz overlies a reddish brown or black subsoil.

Spodosols commonly occur in areas of coarse-textured deposits under coniferous forests of humid regions. They tend to be acid and infertile.

**SPODOSOLS MAKE UP ABOUT 4% OF THE WORLD'S ICE-FREE LAND SURFACE.**

The overall goal of the **Vermont Long-term Soil Monitoring Project**, under the auspices of the Vermont Monitoring Cooperative is to **monitor forest soils for changes due to human-caused impacts**, such as climate change and air pollution.

Major partners in the project:

- Vermont Agency of Natural Resources
- University of Vermont
- USDA Natural Resources Conservation Service (NRCS)
- USDA Forest Service-Green Mountain National Forest
- US Geological Survey.

- In 2002, ten randomly selected subplots at each Vermont Long-term Soil Monitoring Project plot were sampled for the first time.
- The "**Forehead" plot on Mt Mansfield** is the highest elevation plot - approximately 1120 m (3696 ft) on the shoulder of Mount Mansfield, highest summit in Vermont, 1361 m (4493 ft)
- Soil temperature regime is ***cryic***
- Mapped soils at plot are:
  - Londonderry series - *loamy, mixed, active, acid Lithic Cryorthents* (Entisol)
  - Stratton series - *loamy-skeletal, isotic Lithic Humicryods* (Spodosol)
- Bockheim (2010) describes these high-elevation northeastern US soils as "**disjunct**" soils, which have formed on "**widely separated mountain peaks over a broad geographic region**."

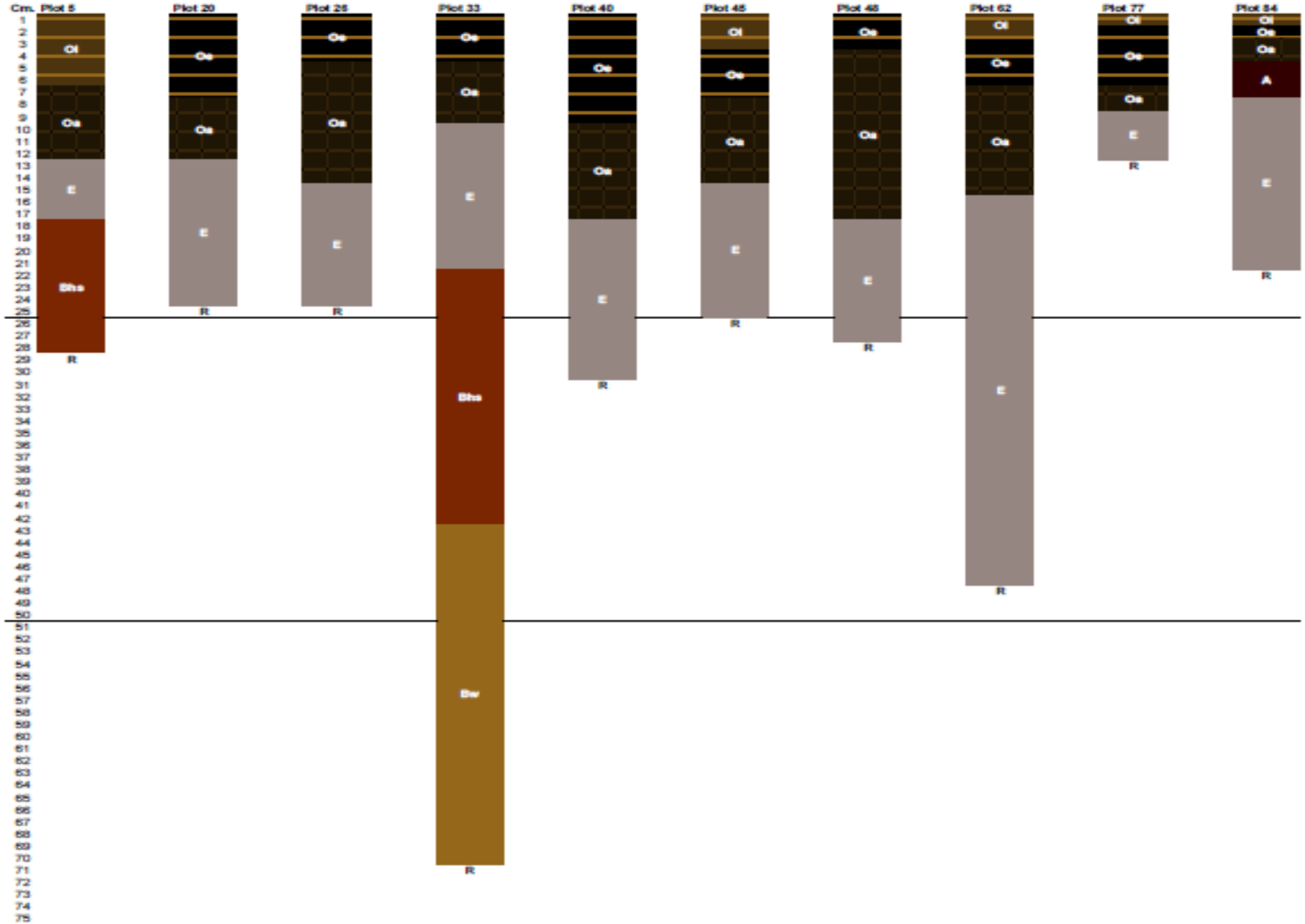
Vegetation is montane spruce-fir forest, primarily balsam fir (*Abies balsamea*), red spruce (*Picea rubens*) and American mountain ash (*Sorbus americana*)

# Results

- Slopes measured at each soil pit ranged from 16 to 38 percent
- All pedons had **surface layer O horizons**, ranging from 4 to 17 cm thick
- All pedons had a **lithic contact to schist bedrock**
- Depth of solum ranged from 12 to 69 cm from the top of the soil surface and from 4 to 60 cm from the top of the mineral soil surface
- Particle size textural class for all mineral layers was *Loamy* or *Coarse-loamy*
- Two pedons had B horizons that met the requirement for spodic horizons (Bhs)
  - One other B horizon was observed - did not meet the requirements for spodic materials (labelled as Bw horizon in description)

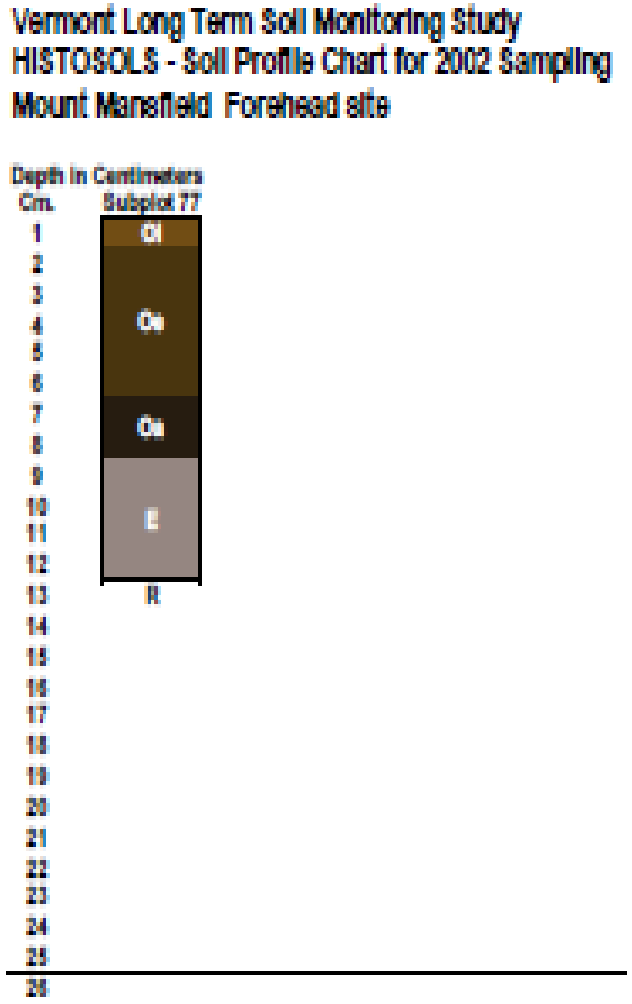
## Vermont Long Term Soil Monitoring Plots - 2002 Sampling - Soil Profile Charts
## Mount Mansfield - Forehead site

Depth in Centimeters



# Histosols

- Small subset in the Northeast found on cold mountain summits and upper sideslopes, such as the Mount Mansfield Forehead plot
- These Histosols have organic soil materials that “constitute two–thirds or more of the total thickness of the soil to a densic, lithic, or paralithic contact and have no mineral horizons or have mineral horizons with a total thickness of 10 cm or less”

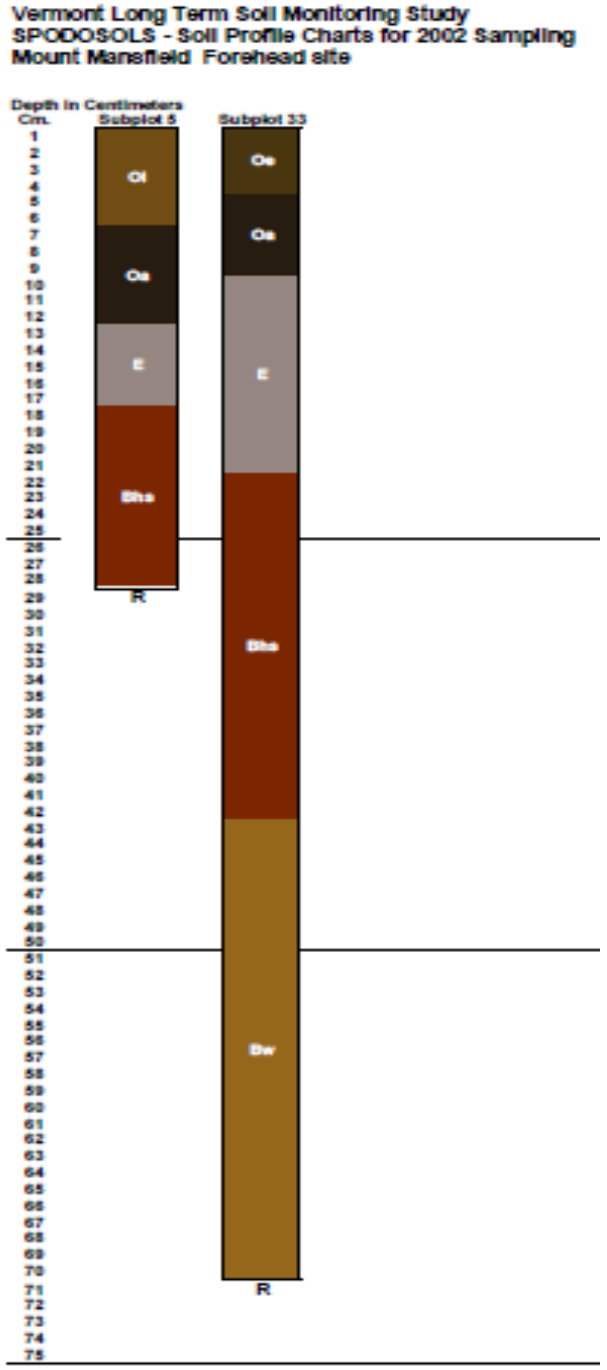


# Spodosols

Common in the Green Mountains of Vermont, but only two pedons have spodic horizons

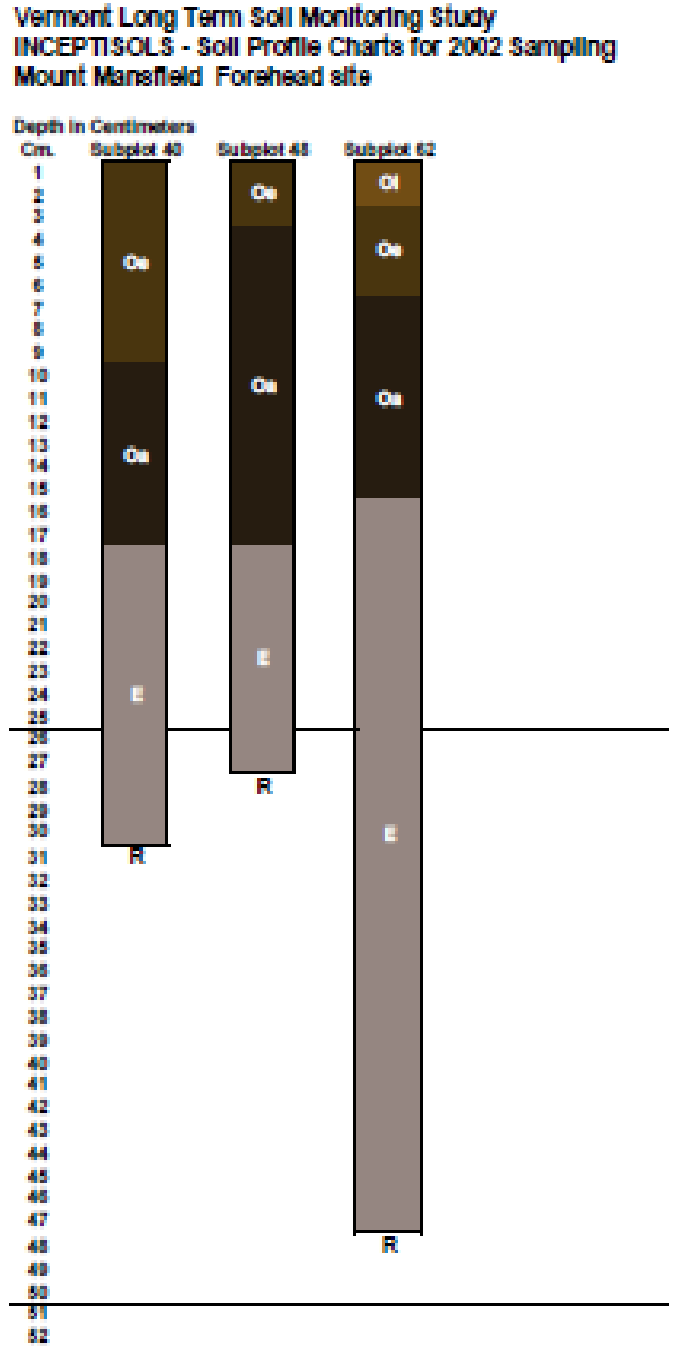
- Bhs horizons have matrix color of 5YR 3/3.

Subplot 33 pedon



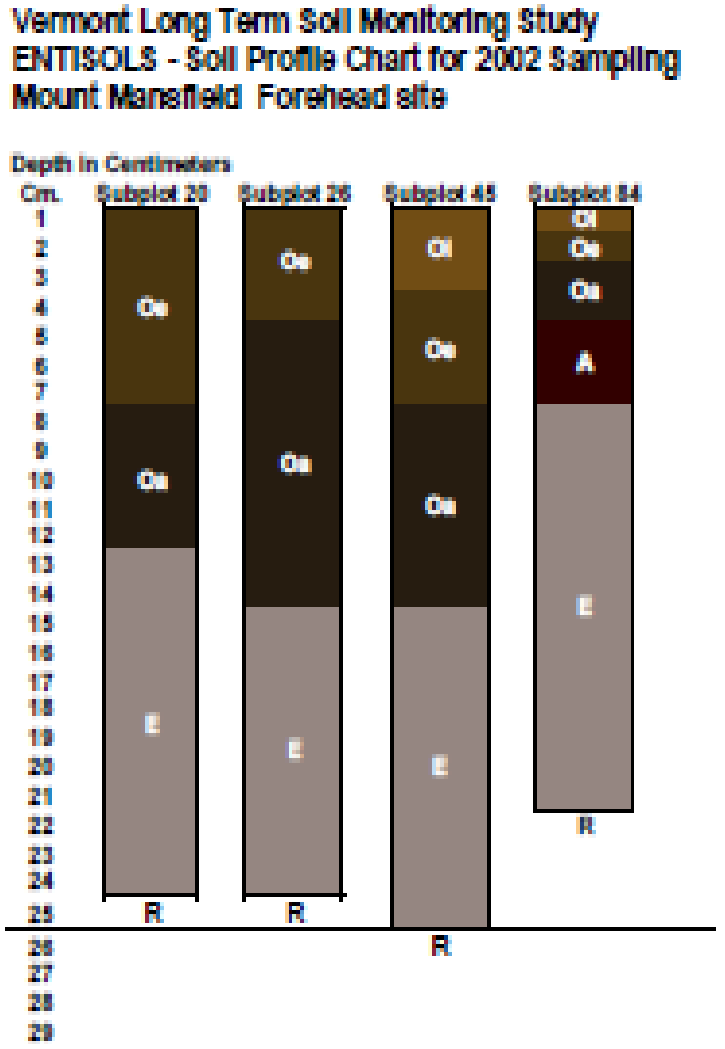
# Inceptisols

- Three pedons have folistic epipedons with combined O horizons 15 cm or more thick. Beginning with the 12th Edition to Keys to Soil Taxonomy (2014), they key out as **Inceptisols**.
- One pedon also has an E horizon 32 cm thick. This is an altered horizon greater than 15 cm thick - meets basic requirements of a cambic horizon, along with meeting the criteria for an albic horizon. With a cryic soil temperature regime, it keys out as an Inceptisol.
- These pedons classify as Lithic Dystrocryepts. Do not fit range in characteristics for any established soil series.



# Entisols

- Four pedons key out as **Entisols**.
- Not Histosols because their O horizons are too thin to equal 2/3rd of the total thickness to the lithic contact.
- Not Inceptisols because the O horizons are too thin to be folistic epipedons and their albic horizons are too thin to meet the requirements for a cambic horizon.
- Not Spodosols because they lack a spodic horizon.
- All four fit the range in characteristics of the mapped Londonderry series.



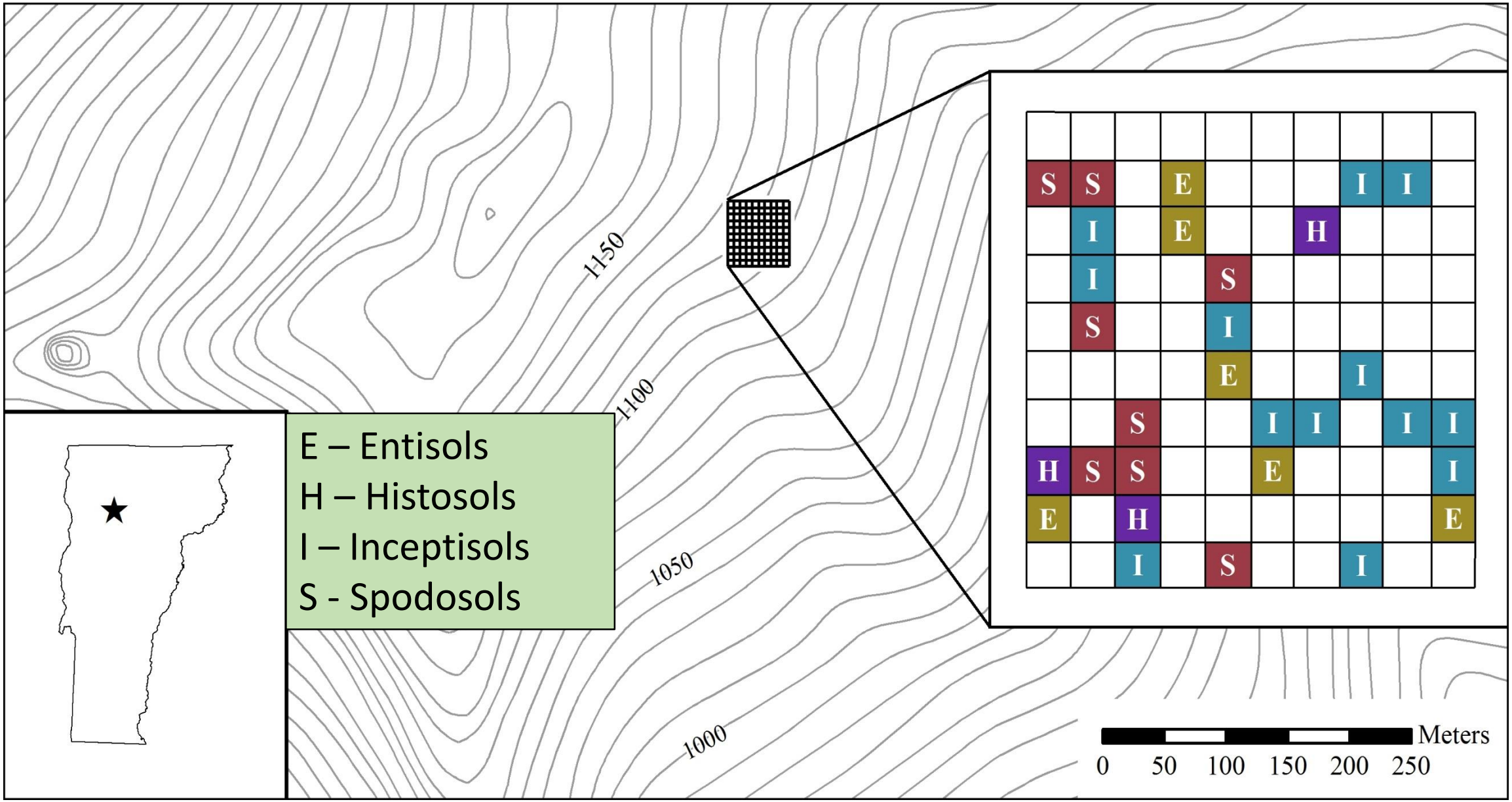
After subsequent 5-year interval sampling of 10 more subplots in 2007 and 2012:

The classification of the 30 pedons sampled to date key out as:

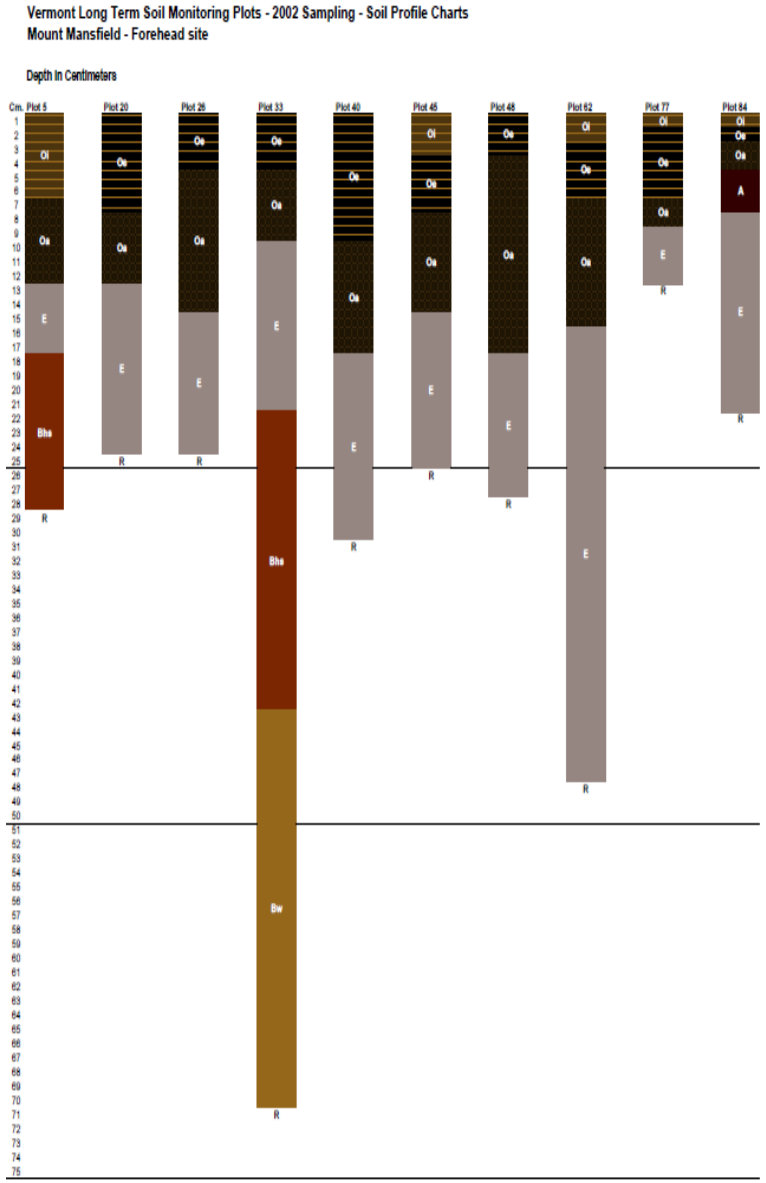
- 13% Histosols
- 27% Spodosols
- 40% Inceptisols
- 20% Entisols

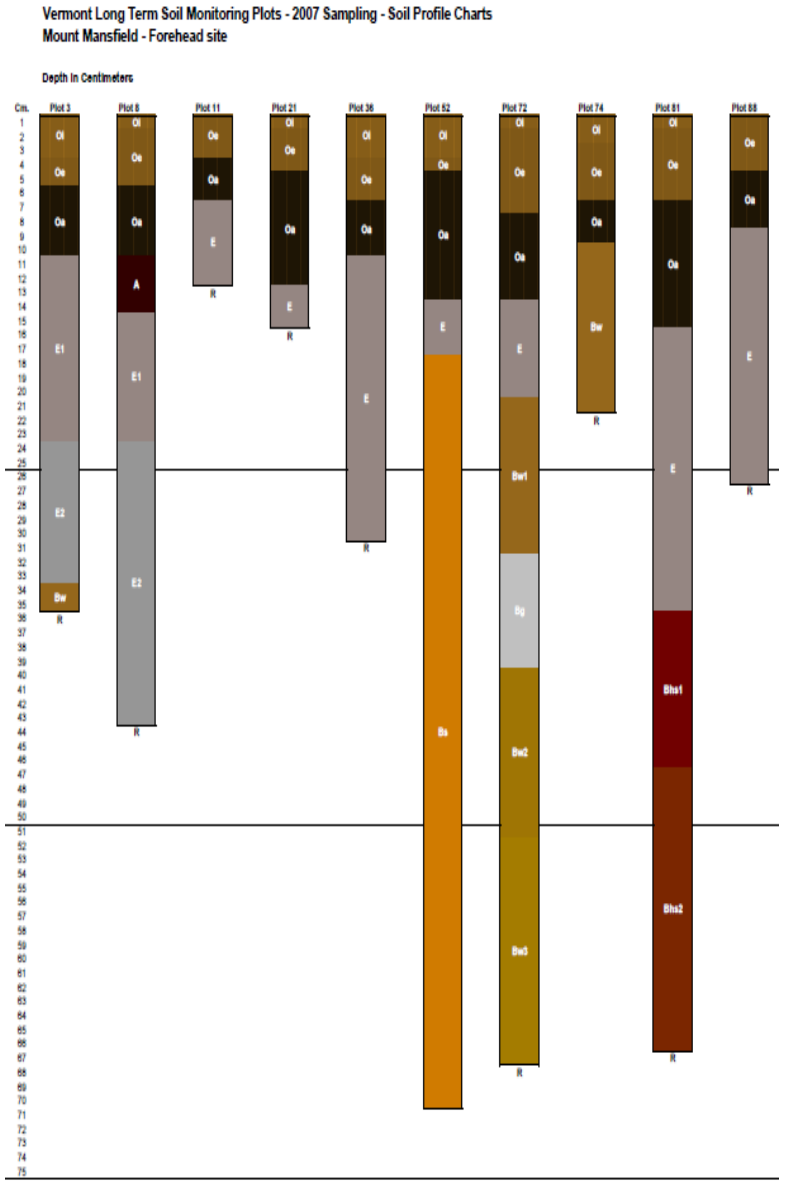
In one corner of the plot, all four soil orders were described within a 15m x 15m area

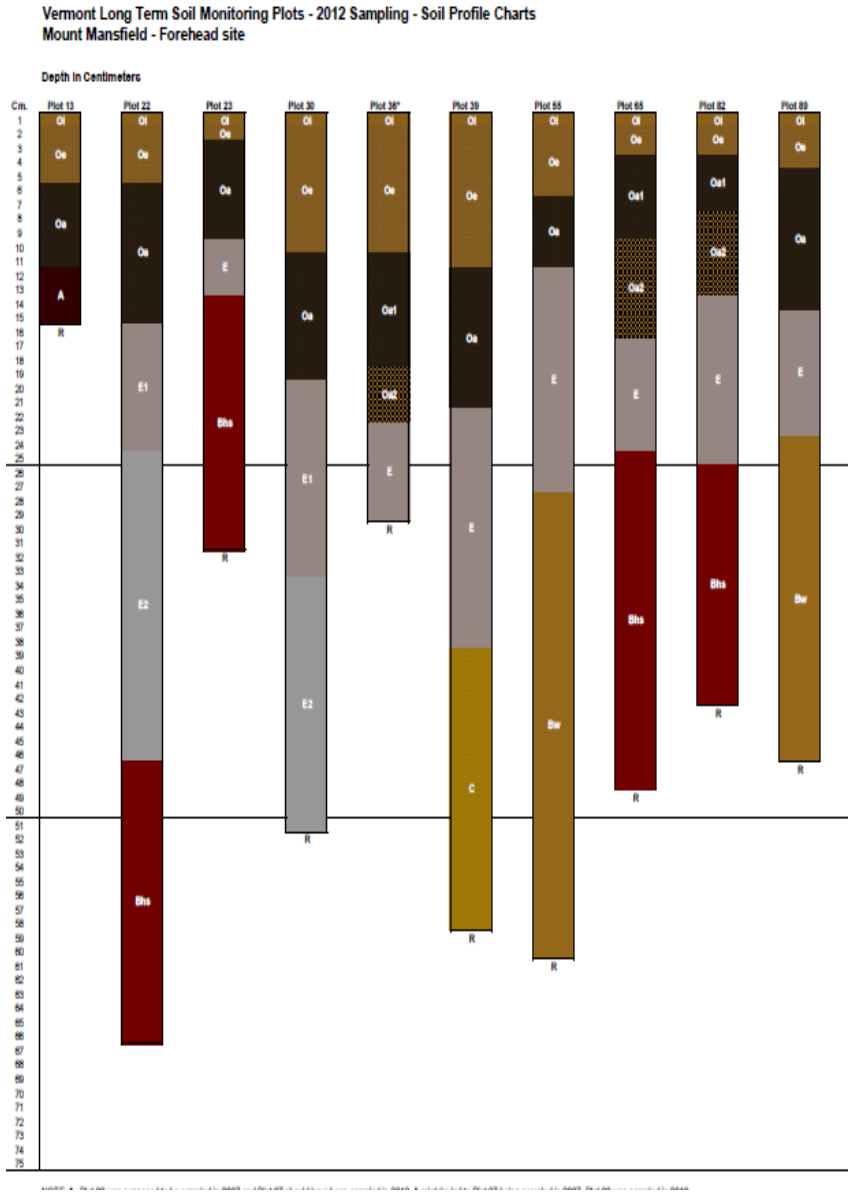
# 2002, 2007, 2012 results



# Soil Profile Charts for 2002, 2007, and 2012 VMC Forehead Plot Sampling



# Closing comments

- The high-elevation spruce-fir “Forehead” plot on Mount Mansfield includes soils of four taxonomic Orders: Entisols, Histosols, Inceptisols, and Spodosols.
  - Site was selected for its supposed uniformity of soils, landscape position and slope.
- Excluding the pedons with spodic horizons, soils with just O, E, and R horizons classify as three different soil orders.
- There are instances where very similar soils can end up looking considerably different when viewed through the lens of Soil Taxonomy.

- The task of observing and describing a soil profile is an important factor in field studies.
- When there is more than one soil scientist or teams of soil scientists working on a project either simultaneously or in sequence, consistency and oversight is critical.
- Best way to insure consistency in soil descriptions -
  - ✓limit the number of people making the descriptions
  - ✓develop a set of protocols to aid in identifying soil horizons.
  - ✓have a single soil scientist review all descriptions after sampling to check for discrepancies.
- The difference of ***one centimeter*** in the recorded depth to the boundary between two horizons can create a significant difference in the classification of a pedon.