# ARCTIC PATTERNED GROUND

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**Patterned ground** is common throughout the Arctic. In this poster we show some of the common types of small patterned ground features that occur on relatively flat sites across the full Arctic bioclimate gradient, and in a variety of soil moisture conditions. The interaction between vegetation, soil and climate creates patterned ground, mainly through contraction cracking, frost heave and vegetation succession (Fig. 1). **Contraction cracking** occurs when the soil contracts due to desiccation or cooling, and occurs on many scales, from centimeters to tens of meters. **Frost heave** occurs due to small ice lenses that form as water in soil freezes. **Vegetation succession** occurs in areas that are stable and protected enough for plants to colonize. In the Arctic, summer temperatures largely control which plants can grow. Climate also controls contraction cracking and frost heave. As vegetation grows, it insulates the soil and retains moisture, reducing contraction cracking and frost heave. The soil, in turn, can limit vegetation growth due to the physical disturbance caused by frost heave, cracking and surface needle-ice (all forms of **cryoturbation**).

Interactions between the soil and the vegetation create patterning: vegetation grows in more stable areas and reduces cryoturbation. In wet, silty soils, less vegetated areas freeze sooner, drawing water in from surrounding areas. Consequently bare areas heave more, resulting in **differential frost heave**.

Contraction cracking, differential heave, and vegetation succession, are each dominant in different parts of the **temperature gradient** (Fig. 2). Contraction cracks are most strongly developed in the extreme High Arctic (Bioclimate Subzones A and B, photos at the top). Differential frost heave affects patterning most strongly in the Middle Arctic regions (Subzones C and D), where mounds and non-sorted circles are surrounded by well-developed vegetation. Vegetation has the strongest effect in the Low Arctic (Subzones D and E) and Boreal Zone (photos at the bottom) where it insulates the soil, stabilizing heave and completely masking contraction cracks.

The **moisture gradient** also affects patterning. Wetter sites (photos to the right) tend to have more vegetation, less contraction cracking, and larger-scaled patterning. Conversely, drier sites (photos to the left) are less vegetated and have more contraction cracking, sometimes at several different spatial scales.

Patterning is also affected by **soil texture**. Rocky soils become sorted by the soil movement associated with cryoturbation. Sandy soils show little patterning. Silty soils retain water better than sandy soils, and yet allow water to move more than in clay soils. As a result, silty soils are susceptible to large annual and differential frost heave. Clay soils tend to retain any deformation, creating permanent features that do not heave much annually.

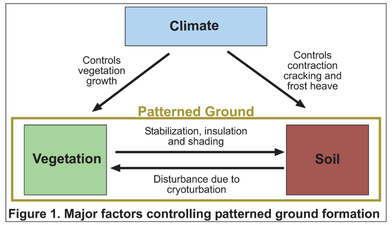


**Figure 1. Major factors controlling patterned ground formation**

## Types of patterned ground

**Non-sorted polygons:** Contraction cracking forms a continuous pattern of small polygons, 10-50 cm in diameter. Vegetation preferentially colonizes in cracks. Cryoturbation keeps centers bare or sparsely vegetated. Small polygons are sometimes aggregated into larger polygons (0.5-2 m) or cracked into tiny polygons (5-10 cm).

**Turf hummocks:** Contraction cracking forms a continuous pattern of polygons, 10-50 cm diameter. Erosion and deposition by wind and water form the shape of the hummocks, 10-25 cm in height. Different types of vegetation grow on the tops and between the hummocks. These often form on gentle to moderate slopes.

**Non-sorted circles:** Differential frost heave forms and maintains a pattern of less vegetated circles that heave more than the surrounding more vegetated areas. These vary in size and spacing, from a continuous pattern with circles 10-50 cm diameter (Subzone A), to scattered large features 1-3 m diameter (Subzones D & E).

**Sorted circles or polygons:** Cryoturbation acting on stony soils sorts larger stones to the edges of these features. These form a continuous pattern of features 0.5-2 m diameter.

**Earth mounds:** These features are formed by differential frost heave. They have different, thinner vegetation on the tops of the mounds than between the mounds. Unlike non-sorted circles, drier soils and/or higher clay content keeps these mounds elevated for most or all of the summer. This is a continuous pattern, with mounds in silty soils soils measuring 0.5-1 m diameter and 15-25 cm tall, and large mounds in clay soils meauring 2-3 m diameter, and 25-100 cm tall.

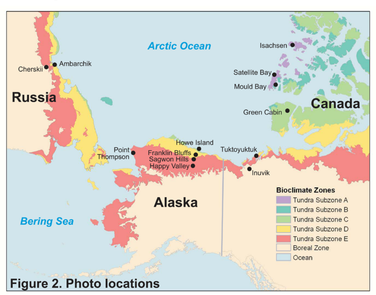


**Figure 2. Photo locations**

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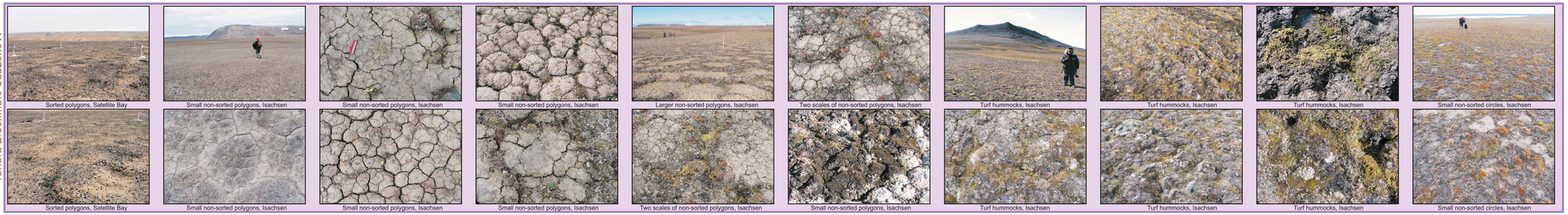
Moisture gradient

DRIER — WETTER

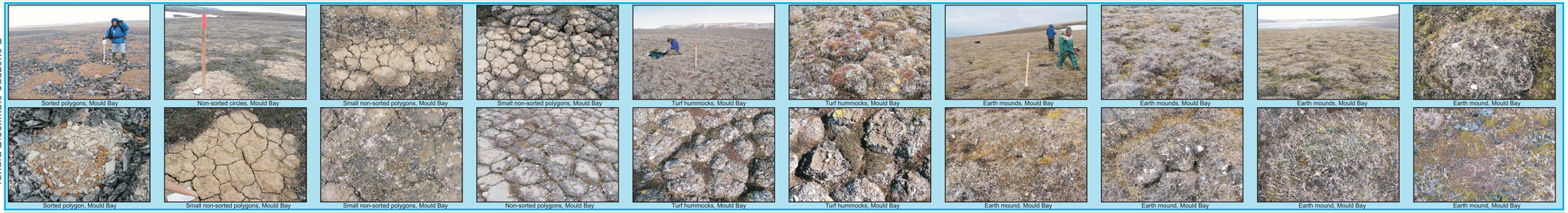
Summer temperature gradient

COLDER — WARMER

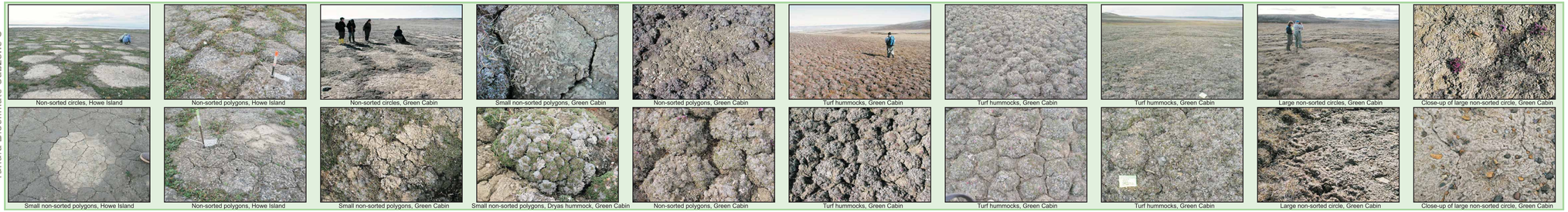
Tundra Bioclimate Subzone A



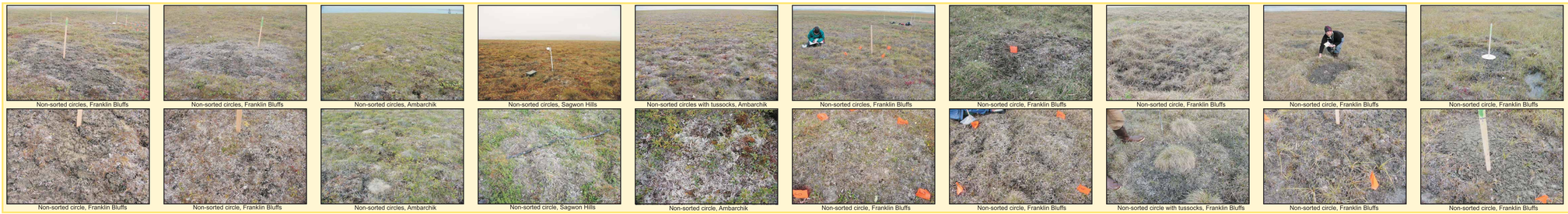

Tundra Bioclimate Subzone B




Tundra Bioclimate Subzone C




Tundra Bioclimate Subzone D




Tundra Subzone E


Boreal Zone


Poster presented at the American Geophysical Union Conference, December 2006, San Francisco, CA.