



FIGURE 1. ALTIPLANATION TERRACES, CANDE C-5 QUADRANGLE, EASTERN SEWARD PENINSULA. THESE FLAT AND BENCHED MOUNTAINTOPS HAVE BEEN ERODED ON MASSIVE ALTERED MESOZOIC ANDESITE BRECCIA. THE BENCHES ARE ABOUT 20-30 FT HIGH AND SEVERAL HUNDRED TO 2000 FT BROAD. BEDROCK CROPS OUT ALONG THE RISERS, AND THE TREADS ARE MANTLED BY ANGULAR RUBBLE THAT IS WATER-SATURATED NEAR THE BACK OF EACH TREAD. PATTERNED GROUND IS COMMON IN THIS RUBBLE. PHOTOGRAPH BY A. R. TAGG, 1961



FIGURE 2. ICE-WEDGE POLYGONS, MOUTH OF MEADE RIVER, ARCTIC COASTAL PLAIN. THE POLYGONS ARE 50-100 FT ACROSS. THESE POLYGONS FORM DURING THERMAL TENSION GENERATED BY THE GROUND'S TENDENCY TO CONTRACT DURING THE COLD ARCTIC WINTER. THE POLYGONAL TENSION CRACKS, FORMED IN WINTER, EXTEND TO DEPTHS OF 10-20 FT. WATER FROM THAWED GROUND AT THE SURFACE TRICKLES INTO THESE OPEN CRACKS DURING EARLY SPRING WHILE THE GROUND AT DEPTH IS STILL CONTRACTED. THE RESULTING VERTICAL ICE VEINS ARE ZONES OF WEAKNESS SUBJECT TO RECURRENT FRACTURE AND GROWTH BY REPETITION OF THE CYCLE IN SUCCEEDING WINTERS. MELTING OF THE TOPS OF THE ICE WEDGES PRODUCES THE SHALLOW TRENCHES. CRACK SYSTEMS TEND TO BOTH PARALLEL AND INTERSECT PERPENDICULARLY THE GRADUALLY RECEDING SHORELINES BECAUSE OF STRESS DIFFERENCES GENERATED BY HORIZONTAL TEMPERATURE GRADIENTS. RANDOM POLYGONS FORM IN AREAS OF MORE NEARLY UNIFORM STRESS. OFFICIAL U.S. NAVY PHOTOGRAPH



FIGURE 3. TOR, ISOLATED STEEP-SIDED BEDROCK KNOB ABOUT 18 FT HIGH IN QUARTZ-MICA SCHIST, BENDLEBEN C-1 QUADRANGLE, SEWARD PENINSULA. THE BLACK OBJECTS ON THE SKYLINE ARE OTHER TORS. THE QUARTZ-MICA SCHIST OF THIS TOR IS ALMOST HORIZONTALLY FOLIATED. THE HILLSIDE AROUND THIS OUTCROP IS MANTLED BY WATER-SATURATED SOIL THAT MOVES GRADUALLY DOWN SLOPE BY CREEP AND SOLIFLUCTION. THE BEDROCK BENEATH THIS SOIL IS RIVED INTO A MIXTURE OF STONES AND FINE SILT. REMOVAL OF SOIL BRINGS BEDROCK WITHIN THE ZONE OF ANNUAL FREEZING AND THAWING ABOVE THE PERMAFROST TABLE AND IT IS THEREBY RENDERED ERODIBLE BY CREEP AND SOLIFLUCTION. THE ROCK OUTCROP WHICH ORIGINALLY MIGHT HAVE BEEN ACCIDENTALLY EXPOSED, IS PRESERVED FROM FROST-HEAVING THROUGH LACK OF AN ABUNDANT SOURCE OF INTERSTITIAL WATER. ITS RELATIVE HEIGHT HAS THEREFORE SLOWLY INCREASED THROUGH LOWERING OF THE GROUND AROUND IT. PHOTOGRAPH BY A. R. TAGG, 1961



FIGURE 4. PINGO IN VALLEY ON SOUTH SIDE OF YUKON-TANANA UPLAND, MOUNT HAYES C-1 AND D-1 QUADRANGLES, 7 MILES NORTHWEST OF DOT LAKE, ALASKA HIGHWAY. THIS NEARLY CIRCULAR HILL, 90 FT HIGH AND 300 FT ACROSS, IS A BLISTER OF ICE, FORMED WHEN GROUND WATER BROKE THROUGH THE CONFINING PERMAFROST AND FROZE BENEATH THE LAYER OF TURF AND SURFACE SOIL. THE ICE CORE HAS BEGUN TO MELT, EITHER BECAUSE THE SURFACE SOIL WAS STRETCHED TO CRACKING AS THE ICE BLISTER ROSE, EXPOSING THE ICE, OR BECAUSE OF SOME LATER CATASTROPHE, PERHAPS A FOREST FIRE. THE MELTING OF THE ICE CORE HAS CAUSED THE HILLTOP TO COLLAPSE INTO A CRATER, NOW FILLED WITH A SMALL LAKE. THE PINGO RISES OUT OF A WATER-LADEN BLACK SPRUCE MUSKOG. ALTHOUGH THEY ARE UNDERLAIN BY ICE, THE SLOPES OF THE HILLS ARE DRY AND SUPPORT A MATURE BIRCH FOREST BECAUSE THEY ARE STEEP AND HIGH ABOVE WATER TABLE. PHOTOGRAPH BY S. WILLIAM HOLMES



FIGURE 5. SOLIFLUCTION LOBES, HEAD OF CHICKEN CREEK, SOLOMON C-5 QUADRANGLE, SEWARD PENINSULA. THESE LOBELIKE SHEETS OF SOIL AND ROCK PROBABLY MOVE DOWNSLOPE BY CREEP AND SOLIFLUCTION. THEY BANK UP AT THEIR LOWER ENDS, PRESUMABLY BECAUSE MOTION AT THEIR LOWER MARGINS IS IMPEDED BY BANKS OF TURF. PHOTOGRAPH BY PHILIP S. SMITH



FIGURE 6. MINIATURE STONE STRIPES, SOUTH SIDE OF REX DOME, FAIRBANKS A-4 QUADRANGLE, NORTHERN FOOTHILLS OF THE ALASKA RANGE. THE LINES OF STONES ARE 3-4 IN APART, ABOUT 1 IN DEEP, AND REST ON FLUFFY CLAY-RICH SOIL ON A SURFACE SLOPING 12° S 50° E. THEY MAY RESULT FROM A COMBINATION OF (1) FROST-SORTING BY WHICH STONES MOVE TO THE SURFACE AND THEN TO THE SIDE OF THE CLAY-RICH AREAS AND (2) SOLIFLUCTION, WHICH CAUSES THE CLAY-RICH CENTERS TO FLOW TOGETHER DOWNSLOPE. STRIPES THIS SMALL PROBABLY FORM WITHIN A FEW DIURNAL CYCLES OF FREEZE AND THAW, WHEREAS LARGER STRIPES, A FEW FEET WIDE, PROBABLY REQUIRE SEVERAL ANNUAL CYCLES TO FORM

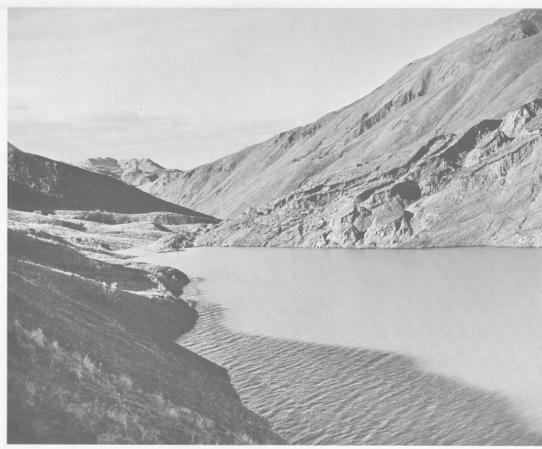


FIGURE 7. SMALL LAKE, DAMMED BY A LANDSLIDE, STONY CREEK, MOUNT MCKINLEY NATIONAL PARK, CENTRAL PART OF THE ALASKA RANGE. PHOTOGRAPH BY BRADFORD WASHBURN



FIGURE 8. BADLAND IN SEQUENCE OF INTERBEDDED POORLY CONSOLIDATED SANDSTONE, CLAYSTONE, AND COAL LIGNITE, CREEK, NENANA COAL FIELD, HEALY D-4 QUADRANGLE, NORTHERN FOOTHILLS OF THE ALASKA RANGE. GROWTH OF THIN SHEETS OF ICE CRYSTALS PARALLEL TO THE BARE SANDSTONE SURFACE HAS PRIED OFF THE SANDSTONE IN LAYERS AND IS RESPONSIBLE FOR THE DELICATELY CURVED THEATER-LIKE BASINS AND SHARP RIDGES OF THIS BADLAND



FIGURE 14. MAP OF ALASKA, WITH GLACIATED REGIONS SHOWN STIPPLED, SHOWING LOCATIONS OF PHOTOGRAPHS



FIGURE 9. BADLAND EROSION, SCULPTURING OF A CLIFF FORMED AS A MEANDER SCAR, EAST BANK OF NENANA RIVER NEAR HEALY, NORTHERN FOOTHILLS OF THE ALASKA RANGE. THE DELICATELY FLUTED BADLAND CLIFFS ARE IN COARSE, POORLY SORTED CONGLOMERATE OF TERTIARY AGE. EROSION IS PREDOMINANTLY BY FROST PRYING OF SOME OF THE BOULDERS OF THE CONGLOMERATE, AND KNOCKING LODGE OF OTHER BOULDERS AS THE FROST-WEDGED BOULDERS BOUNCE DOWN THE SLOPES. SHAPE AND SPACING OF THE ALCOVES APPEAR TO BE CONTROLLED BY DISTANCE THE BOULDERS BOUNCE FROM SIDE TO SIDE AS THEY DESCEND THE CLIFFS



FIGURE 10. LOWER END OF RED GLACIER, MOUNT ILIANKA, SOUTHERN PART OF THE ALASKA RANGE, LOOKING SOUTHEAST. A TYPICAL MORaine-COVERED STAGNATING GLACIER. THE SURFACE OF THE GLACIER IS A CHAOTIC ARRAY OF STEEP MOUNDS, RIDGES, AND CIRCULAR PITS. MOST OF THE MOUNDS AND RIDGES ARE ICE, WITH A DEBRIS COVER ONLY A FEW FEET THICK. A FEW GROVES OF ALDER BUSHES GROWING ON THE SURFACE OF THE MORaine-COVERED GLACIER ARE RENDERED DISTINCT BY THEIR DARK TONE. ALONG THE LEFT MARGIN OF THE GLACIER CAN BE SEEN A SERIES OF ICE-MARGINAL LAKES, JOINED BY A MARGINAL STREAM. THIS STREAM IS FILLING THE LAKES WITH SAND AND GRAVEL AND HAS CUT A DEEP NOTCH BETWEEN THE GLACIER AND THE BEDROCK RIDGES BETWEEN THE LAKES. WHEN THE ICE IS GONE, THIS DEEP NOTCH WILL APPEAR AS A MARGINAL BENCH ON THE VALLEY WALL, AND THE GRAVEL-FILLED LAKE BASINS WILL BE KAME TERRACES. THE MELT-WATER STREAM BEYOND THE TOE OF THE GLACIER IS BUILDING AN OUTWASH DELTA INTO COOK INLET. PHOTOGRAPH BY BRADFORD WASHBURN



FIGURE 11. POLYGONAL GROUND, MOUNTAIN TOP EAST OF REX DOME, FAIRBANKS A-4 QUADRANGLE, NORTHERN FOOTHILLS OF THE ALASKA RANGE. THE CLAY-RICH CENTERS OF THESE POLYGONAL MOUNDS SWELL AND COLLAPSE SUFFICIENTLY FROM FREEZING AND THAWING OF ICE THAT THEY DESTROY THE ROOTS OF ANY PLANTS THAT GROW ON THEM. THE PLANTS GAIN A FOOTHOLD ONLY ALONG THE RELATIVELY CLAY-FREE BORDERS, WHICH DO NOT HEAVE AS MUCH AS THE CENTERS



FIGURE 12. STONE POLYGONS, DENALI HIGHWAY EAST OF MACLAREN RIVER, MOUNT HAYES A-5 QUADRANGLE, CLEARWATER MOUNTAINS. NOTE THE COMPLETE SORTING BETWEEN THE CLAY-RICH CENTERS AND THE BORDERING LINES OF COARSE BOULDERS. THESE POLYGONS PROBABLY FORM AS FOLLOWS: BOULDERS IN THE TILL ARE HEAVED TO THE SURFACE BY ICE LENSES THAT GROW BENEATH THEM. THE AREAS RICHEST IN CLAY HEAVE HIGHER IN WINTERTIME THROUGH ACCUMULATION OF ICE LENSES THAN THE SURROUNDING AREAS, AND ONCE ON THE SURFACE, THE BOULDERS SLIDE OFF THE CLAY-RICH AREAS DURING SPRING THAW TO ACCUMULATE AS A POLYGONAL BOULDER NET. THIS PROCESS EVENTUALLY MAKES A CLEAN SORTING BETWEEN BOULDERS AND FINER MATERIAL



FIGURE 13. DEPOSITS AND LANDFORMS LEFT BY A RETREATING GLACIER, WOODWARD GLACIER, VALDEZ A-4 QUADRANGLE. THE SMOOTHLY ROUNDED FAINTLY CREVASSED GRAY BODY IN THE RIGHT BACKGROUND IS THE ICE OF THE RETREATING GLACIER. THE STRAIGHT PARALLEL RIDGES AND GROOVES IN THE CENTER RIGHT WERE MODELLED BY THE GLACIER IN THE SOFT TILL OF ITS FLOOR AS IT ADVANCED. THE LONG SINUOUS ANASTOMOSING RIDGE BUILT ACROSS THE CENTER OF THE GROOVED TOPOGRAPHY IS AN ESKER, A RIDGE OF GRAVEL DEPOSITED BY A STREAM FLOWING IN A TUNNEL BENEATH THE ICE. THE STREAM EMERGED FROM BENEATH THE GLACIER IT BUILT A BROAD OUTWASH FAN. A BRAIDED MELTWASH STREAM IS BUILDING AN OUTWASH PLAIN IN THE FOREGROUND ACROSS THE LOWER EDGE OF THE GROOVED TILL PLAIN. PHOTOGRAPH BY BRADFORD WASHBURN