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The October 2013 Lithosphere is now online. Locations studied include the Central Iberian Massif in Spain; Arctic Alaska; the Wet Mountains of Central Colorado, USA; the Basgo Formation in northwest India; Crystal Geyser in southeastern Utah, USA; Knight Inlet in the southwestern Coast Mountains Batholith, British Columbia, Canada; and three crustal-scale shear zones in the western Canadian Shield of northern Saskatchewan. Lithosphere is published bimonthly in hardcopy; articles are posted online as they become available.

***************Large-scale flat-lying isoclinal folding in extending lithosphere: Santa María de la Alameda dome (Central Iberian Massif, Spain)

César Arango, Rubén Díez Fernández, and Ricardo Arenas, Universidad Complutense de Madrid, Geology, Madrid, Madrid 28040, Spain; http://dx.doi.org/10.1130/L270.1.

Just like today, ancient mountain chains were raised and dismantled by a combination multiple processes. In this paper, César Arango and colleagues describe the dismantlement of the internal parts of the mountain belt formed while the major land masses existing about 300 million years ago joined together to form Pangea. Arango and colleagues selected a nicely exposed section of this mountain chain in Central Iberia, Spain. Due to the collision of continents Gondwana and Laurussia back then, the Earth's crust in this zone became very thick, to a point that rocks started to flow laterally in order to compensate such a gravitational disequilibrium in the margins of these two continents. This way, the rocks located deep inside that mountain belt accommodated large lateral displacements, and therefore they were strongly deformed. Thanks to erosion, today it is possible to recognize the mechanisms by which those rocks were deformed, being the formation of kilometer-scale folds affecting the different layers of rock one of the most important.

***************Laurentian origin for the North Slope of Alaska: Implications for the tectonic evolution of the ArcticJustin V. Strauss et al., Dept. of Earth and Planetary Sciences, Harvard University, 20 Oxford Street, Cambridge, Massachusetts 02138, USA; Francis A. Macdonald, John F. Taylor, John E. Repetski, and William C. McClelland; http://dx.doi.org/10.1130/L284.1.

The Arctic region remains a modern-day frontier for geologists. Both the tectonic history of the circum-Arctic continental margins and a comprehensive model to explain the opening of the Arctic Ocean are still hotly debated. This is mostly due to a lack of field-based geological data from this remote part of the planet. In this paper, Justin Strauss and colleagues provide new geochronological and paleontological data from the Brooks Range of Alaska that help elucidate the origin and travels of Arctic Alaska, a continental fragment that was accreted to the northwestern margin of North America in the Jurassic-Cretaceous. Based on these new data, we show that Arctic Alaska most likely originated as a piece of eastern North America and was subsequently displaced to its current position in a complex series of Devonian-Carboniferous orogenic events in the Canadian Arctic. These new constraints will help geoscientists unravel the complex tectonic history of a region that remains a geological enigma and hosts some of the largest untapped hydrocarbon deposits left on Earth.

***************Relationship between syndeformational partial melting and crustal-scale magmatism and tectonism across the Wet Mountains, central ColoradoJamie S.F. Levine, Dept. of Geology, Appalachian State University, Boone, North Carolina 28608, USA; Sharon Mosher, and Christine S. Siddoway,; http://dx.doi.org/10.1130/L287.1.

The Wet Mountains of central Colorado, USA, represent an ancient mountain belt that is now exposed. This mountain range is more than one billion years in age; it extends in a northwest-southeast orientation, and contains rocks that were once quite hot, buried deep in the crust. Outcrops present in the northwest portion of the Wet Mountains were not buried as deeply and didn’t experience temperatures as high as those exposed in the southeast portion of the range. Using detailed textural observations under the microscope in conjunction with field-based analysis, Jamie S.F. Levine, Sharon Mosher, and Christine S. Siddoway find evidence for melting within these rocks, with minor melting in the northwest and far more abundant melt in the southeast. In the central and southeastern part of the range, there are more abundant granite bodies which may have helped to insulate the crust and could have acted as a blanket, keeping rocks below these granite bodies at elevated temperatures and aiding in partial melting of these rocks. Geophysical imaging of many modern mountain belts suggest there is a layer in the middle crust that is partially molten, and thus the Wet Mountains may provide an older exposed analog to active mountain belts.

***************Evidence of Pre-Oligocene emergence of the Indian passive margin and the timing of collision initiation between India and EurasiaAlka Tripathy-Lang, Arizona State University, School of Earth and Space Exploration, Tempe, AZ 85287-1404, USA; and Kip V. Hodges, Matthijs C. van Soest, and Talat Ahmad; http://dx.doi.org/10.1130/L273.1.

In this study, Alka Tripathy-Lang and colleagues address the timing of collision between the Indian and Eurasian lithospheric plates, a process that formed arguably the most spectacular landform on earth -- the Himalayan-Tibetan orogenic system. They demonstrate that the source area for the Basgo Formation, a package of sedimentary rocks in NW India that lies within the zone of collision, includes material derived from both plates. Coarse cobbles came from the north, whereas finer sands came from the south. When presented with a mixed source region, the implication is that Eurasia (northern source) and India (southern source) were close enough to one another to contribute sediment to a common basin. The Indian source area specifically seems to be the paleo-Indian passive margin, which is analogous to the Atlantic margin of North America today. Additional study demonstrates that the Indian continental margin source region for the Basgo Formation had emerged from below sea level and was shedding sediments to the Basgo Formation by 50 million years ago as a consequence of India-Eurasia collision. This precludes collision having occurred at 35 million years. Instead, the data presented here support the hypothesis that collision commenced around 50 million years ago.

***************Transpressive uplift and exhumation of continental lower crust revealed by synkinematic monazite reactionsGregory Dumond, University of Arkansas, Geosciences, Fayetteville, Arkansas 72701, USA; and Michael L. Williams, and Michael J. Jercinovic; http://dx.doi.org/10.1130/L292.1.

Rare exposures of deep continental crust provide important information about the behavior of Earth's tectonic plates during mountain building. Studies of deep crust require knowledge of the timing of deformation during two intervals of time: (1) during the time crust was deformed at depth, and (2) during the time this deep crust was uplifted and brought near Earth's surface. This study by Gregory Dumond and colleagues uses in-situ dating of the mineral monazite to constrain the timing of movement on three large-scale shear zones that facilitated uplift of more than 20,000 square kilometers from greater than 40 km depths to greater than 20 km depths. Monazite grew during metamorphic reactions that occurred synchronous with deformation along all three shear zones at 1,849 plus or minus six million years ago. This study demonstrates how mutually interacting thrust and strike-slip shear zones can simultaneously accommodate uplift and exhumation of Earth’s deep continental crust.

***************Rapid river incision across an inactive fault -- Implications for patterns of erosion and deformation in the central Colorado PlateauJoel Pederson et al., Utah State University, Geology, 4505 Old Main Hill, Logan, Utah 84322, USA; and Neil Burnside, Zoe Shipton, and Tammy Rittenour; http://dx.doi.org/10.1130/L282.1.

Despite its iconic landscapes, the geologic workings of the Colorado Plateau remain an active research problem and a source of controversy. Researchers have recently proposed multiple sources of uplift and intriguing patterns of erosion, yet little or no constraints exist in the heart of the plateau to test these ideas. Joel Pederson and colleagues present results from a detailed record of absolute-dated river terraces at Crystal Geyser in southeastern Utah, USA, where the Little Grand Wash fault crosses the Green River in the broad Mancos-shale badlands of the central plateau. They find that there has been no surface rupture of the fault in the past 100,000 years, and the Little Grand Wash fault contrasts with other faults in the region that are presently active due to movement of subsurface salt deposits. Pederson and colleagues hypothesize that there may be a Pliocene component of fault slip in the region linked to broad-scale erosion, unloading, and domal rebound. The Green River at Crystal Geyser, on the other hand, has incised at a relatively rapid pace of 45 cm/thousand years (450 m/million years) over the last 100,000 years, and there is an apparent rapid decrease in incision rates just upstream through Desolation Canyon, suggesting the river has recently experienced an upstream-migrating wave of incision.

***************Paleogeography of the Insular and Intermontane terranes reconsidered: Evidence from the southern Coast Mountains Batholith, British ColumbiaMargaret E. Rusmore et al., Occidental College, Geology, Los Angeles, California 90041, USA; and Scott W. Bogue, and Glenn J. Woodsworth; http://dx.doi.org/10.1130/L288.1.

New geologic and paleomagnetic data from Knight Inlet in the southwestern Coast Mountains Batholith, British Columbia, support significant revision to the paleogeography of the Insular and Intermontane terranes. Recompilation of radiometric ages confirms that after 100 million years ago, a magmatic arc migrated northeastward across the Coast Mountains Batholith at ~2 km per million years. Magmatic age patterns suggest that plutons older than 100 million years intruded the Intermontane terrane, not the expected Insular terrane. The distribution of brittle faults along Knight Inlet defines a structurally intact central domain, ~45 km wide, flanked to the SW and NE by faulted domains, with no evidence of the widespread Tertiary extension affecting the batholith farther north. Aluminum-in-hornblende geobarometry yields emplacement depths of ~2.5 to 4 kbar and does not reveal systematic post-emplacement tilting. Plutons in the central structural domain yield a consistently oriented paleomagnetic remanence presumably acquired as the Late Cretaceous arc cooled from approx. 110 to 85 million years ago. In the absence of recognizable tilting, this result indicates ~1,700 km of northward translation since about 85 million years ago, which is significantly less than predicted for the Insular terrane in the "Baja British Columbia" model but similar to results from the Intermontane terrane. The pluton ages and the paleomagnetic results suggest that the Intermontane terrane, not the Insular terrane, underlies the southwestern flank of the Coast Mountains Batholith. This conclusion is compatible with a paleogeographic model in which the Vancouver Island fragment of Wrangellia was juxtaposed against the Intermontane terrane prior to about 120 to 100 million years ago and emplaced in southern British Columbia after about 75 million years ago.

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