Geology on Taita hills

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Contents

• Taita Hills geology
• Marble
• Uses of marble
• Marble as an archive of past oceans
Taita Hills geology

- Part of a geological map by Horkel, Okello, Pohl and Wakhira (1975)
- Bedrock mostly formed 600 – 850 million years ago
- Blue areas are marble, which is our research target
- Marble layers are relatively common in Taita Hills area
Marble

- Marble is metamorphosed limestone
- Metamorphosis means that the original limestone have been buried deep in the Earth’s crust to high temperatures and pressures
- Pressure > 20 km depth
- Temperature \(\approx 650^\circ\text{C}\)
- Grainsize of minerals typically 5 – 20 mm

Marble from the Kasigau area
Constituents of marble

- **Calcite** = calcium carbonate = $\text{CaCO}_3$
- **Dolomite** = calcium-magnesium carbonate = $\text{CaMg(CO}_3\text{)}_2$
- Quartz, other silicate minerals and graphite as impurities
Uses of calcite and dolomite

• Calcium carbonate has a large number of industrial applications, including:
  – building industry, building stones, aggregates
  – raw material for quicklime, slaked lime, cement and mortar
  – white filler material in paper industry

• Examples of dolomite use are:
  – use as building stone
  – concrete aggregate
  – in agriculture to buffer the acidity of soil

Single family owned marble quarries in the Mwaketutu area
Origin of marble

- Marbles are transformed from limestones
- Limestones represent calcite or dolomite precipitation as lime mud on the ocean floor, initially grain size < 0.02 mm
- Calcite and dolomite are mostly precipitated in shallow water, under warm climates
- To avoid oversaturation, calcium, magnesium and carbonate are continuously precipitating from the seawater as calcite and dolomite
- Some limestones get eroded, some limestones are buried under mountain chains and are transformed into marbles
Chemical and isotopic composition

- Calcium
- Magnesium
- Carbonate
- Iron, manganese, strontium
- Isotopic composition of carbon: the $\delta^{13}\text{C}$ value (carbon is made of two different isotopes $^{13}\text{C}$ and $^{12}\text{C}$)
- $\delta^{13}\text{C}$ value is a per mille difference from an international standard, which in the case of carbon is VPDB
Information from carbon isotopes

- Limestones get there $\delta^{13}C$ values from seawater. Marbles, in turn, inherit their $\delta^{13}C$ from limestone
- Marbles and limestones are archives of the carbon isotope composition of ancient seawaters
- Taita area marbles have been deposited on the seafloor around 600 – 900 million years ago (This sea does not exist any more)
- Carbon isotopes could possibly be used to constrain the time of the carbonate sedimentation in the Taita Hills area
History of the carbon isotope composition of seawater

(Karhu, 1999)

• $\delta^{13}C$ of seawater has varied systematically
Conclusions

• Marbles are an interesting topic for studies
  – They have industrial and other commercial uses
  – They carry information from the distant past, from oceans that do not exist any more