

The Effect of the Himalaya-Tibetan Plateau Uplift on the Asian Monsoon

By Amelia Johnson

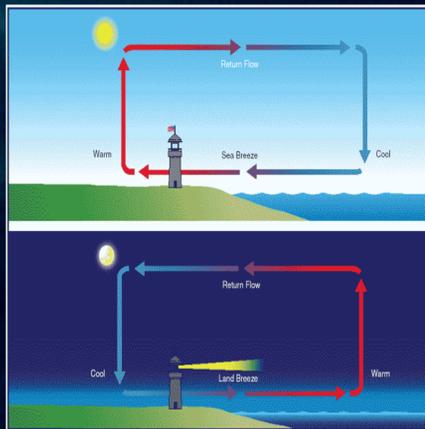
Research Methods and Results

Abstract

The Tibetan Plateau was uplifted 8 million years ago. This intensified the Indian monsoon. Evidence to support this claim is also shown in weathering rate increases 9-8 million years from strengthening winds, indicating an enhanced monsoon. Also, evidence in the fossilized skeletons of Planktonic foraminifer from 8 million years ago in marine cores provide evidence for upwelling. Along with other proxies occurring at corresponding times, evidence points supports that the uplift inflicted the further establishment of the monsoon.

Introduction

• Monsoon season: June to October and November to April



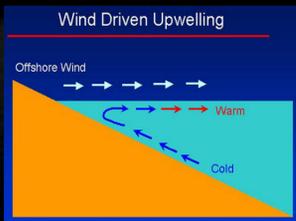
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- Land breezes and sea breezes: caused by differential heating between Indian continental crust and Pacific Ocean
- Differential heating: caused by ocean turbulence and specific heat
- Separate air temperatures create convection currents (monsoon winds)
- Brings moisture (precipitation) along with sea breeze wind in summer
- Winds reverse during winter and blow dry air from over land out to sea (Webster, 2012)

- Uplift strengthened the monsoon because winds were constrained between the plateau and the stratosphere
- Himalayas uplifted 8 million years ago because of convergent plate boundaries between Indian and Asian plates
- Precipitation falls on uphill side of the Himalayas and prevents moisture from moving inland (Harris, 2006)



quake.eas.gatech.edu

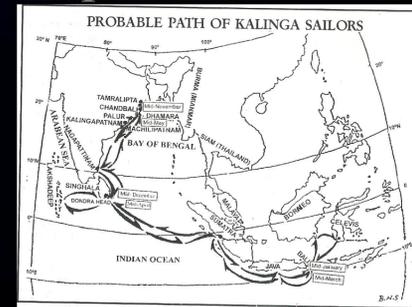


• [Frf.usae.army.mil](http://frf.usae.army.mil)

Upwelling:

- often caused by winter
- monsoon winds
- cool, dense, nutrient rich water from the lower layers of the ocean is pushed upward (Webster, 2012)

Implications for Society



• kalingacalling.blogspot.com

- Strong steady winds have determined trade routes throughout history between China and India

• en.wikipedia.org

- Precipitation forms rivers which helped many ancient civilizations develop in the Indus River Valley



www.indiaspend.com

- Effects global economy through agriculture of sugar and cotton
- India can turn from an export nation in one monsoon season
- (India would otherwise be desert)



www.asianews.it

- Can change river courses, wipe out villages, and cause massive floods (Beck, et al, 2005), (Slow Monsoon threatens India crops, 2012)

Discussion

Other variables were not constant throughout history and could have strengthened the Monsoon, not solely the Plateau Uplift:

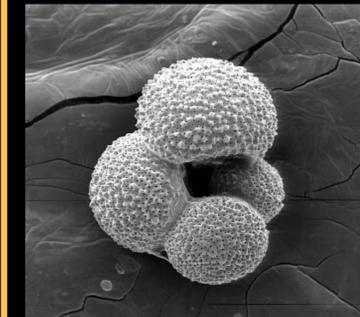
- Carbon Dioxide levels
- Solar Radiation levels
- Glacial condition
- Tectonic plate position

Also, the model was not completely accurate.



www.andrill.org

- Marine cores drilled from the Indian Ocean
- Globorina bulloides: microscopic marine organisms that live in the Photic Zone of the ocean and have mineral shell-like structures
- The mineral remains float to the ocean floor and become part of the sedimentary bedrock
- (Zhisheng, et al, 2001)



www.noaanews.noaa.gov

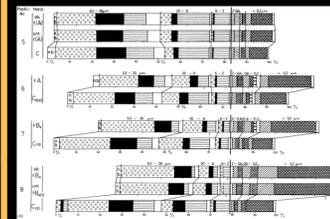
- Increased nutrients in the Photic Zone because of Upwelling increases the G. bulloides population
- Sedimentary records show that upwelling occurred 8Ma and continuously thereafter
- (Zhisheng, et al, 2001)



www.emw21.com

- Loess Paleosols in Luochuan, China are sedimentary formation made of loess silt
- Loess silt has a very small grain size, which shows that it is formed and transported by wind erosion, the monsoon winds
- (Zhisheng, et al, 2001)

• observation of the Rubidium/Strontium ratio with radioactive dating, methods shows that the paleosols were formed roughly around the same time as the Himalayan Uplift (8Ma)

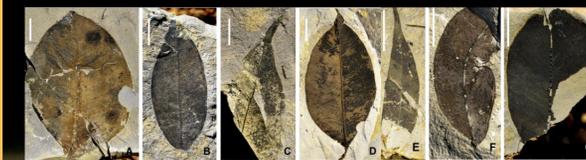


(Zhisheng, et al, 2001) www.sciencedirect.com

- CMM1 is an atmospheric model that ran for 25 years, simulating one monsoon season in 30 minutes
- It had three settings: mountain (a raised platform), half-mountain, and full mountain to simulate the Tibetan plateau

Other Proxies:

- A strengthening monsoon would change the planet, and therefore the plants that live in the affected area.
- changes in the shape of leaves in Tibet are sown in leaf fossils from around 8Ma
- (Zhisheng, et al, 2001)



www.sciencedirect.com

- Differences were observed between the climate with the three settings
- Overall, temperatures decreased and temperatures increased with a fully raised mountain
- (Prell and Kutzbach, 1992)

Area	Model	July T, ΔT			January T, ΔT			July P, ΔP			January P, ΔP		
		NM	M	Δ	NM	M	Δ	NM	M	Δ	NM	M	Δ
Tibet	CCM1	35	13	-22	-12	-26	-14	1.7	5.9	4.2	1.2	1.2	[0]
	CCM0	28	18	-10	-6	-17	-11	3.3	5.3	2.0	1.4	1.3	[-1]
South Asia	CCM1	38	26	-12	11	4	-7	3.0	9.0	6.0	1.6	2.6	1.0
	CCM0	30	26	-4	10	9	[-1]	4.0	9.2	5.2	1.4	2.3	.9
East Asia	CCM1	33	20	-13	-11	-26	-15	3.1	9.3	6.2	2.0	1.5	-5
	CCM0	27	26	[-1]	-11	-17	-6	3.6	5.0	1.4	1.8	1.8	[-0]

- increased monsoon precipitation increases the river velocity of Himalayan runoff rivers
- Increased velocity increases erosion of riverbeds
- Eroded sections in riverbed sedimentary records show an intensified monsoon roughly 8Ma
- (Zhisheng et al, 2001)

Conclusion

- Correlating proxies all at the same time (8 Ma)
- Lead to the conclusion of a strengthening monsoon because of the Tibetan Plateau Uplift

References

- Harris, N. (2006). The elevation history of the Tibetan Plateau and its implications for the Asian monsoon. In *Science Direct*. Elsevier B.V.
- Kutzbach, J. E., Prell, W. L., & Ruddiman, W. F. (1993). Sensitivity of Eurasian Climate to Surface Uplift of the Tibetan Plateau. *Chicago Journals*, 101 (2), 177-190.
- Prell, W. L., & Kutzbach, J. E. (1992, December). Sensitivity of the Indian monsoon to forcing parameters and implications for its evolution. *Nature*, 360, 647.

- Slow monsoon threatens India crops. (2012, July 18). Retrieved December 19, 2012, from Anirudh Sethi Report website: <http://www.anirudhsethireport.com/slow-monsoon-season-threatens-india-crops/>
- Webster, P. J. (n.d.). Monsoon. Retrieved from Grolier Multimedia Encyclopedia database.
- *World history; Patterns of interaction* (R. B. Beck, L. Black, L. S. Krieger, P. C. Naylor, & D. I. Shabaka, Comps.). (2005). Evanston, IL: McDougal Littell.
- Zhisheng, A., Kutzbach, J. E., Prell, W. L., & Porter, S. C. (2001, May 3). Evolution of Asian monsoons and phased uplift of the Himalaya-Tibetan plateau since late Miocene times. *Nature*, 411, 62-66.