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A Site Search for A Cosmic Ray Station Above 6000 M Elevation in Tibet

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Abstract

Earlier discussions have noted the potential advantages of a cosmic ray station above 6000-m elevation, and suggested that Tibet would be a probable host location. A site, accessible by road and with an elevation of about 6100-m has been identified near New Tingri in Tibet, about 100 km north of Mt. Everest. Details (weather, etc.) of this site are presented and discussed.

1 Introduction:

In discussions dating back to 1980 and to the Paris XVII ICRC in 1981, one of us has promoted the idea of a cosmic ray station at an elevation higher than the existing sites in Bolivia (Chacaltaya) and Tibet (Mt. Kamba La), both at approximately 5200-m. In these presentations (Jones (1980) - Jones (1998)) it was argued that this "frontier" of high elevation sites could and should be extended, and that Tibet would be the most probable locale for such a site. It has been learned recently that the Chinese have explored a site near New Tingri in Tibet for meteorological research, and this site, at about 6100 meters above sea level, may be a promising candidate for a station satisfying the criteria identified earlier.

2 The Sheka Site:

The highway from Lhasa, Tibet to Katmandu, Nepal passes through New Tingri 250 km northeast of the Tibet-Nepal border; this small community boasts a hotel, and, at 4300-m elevation, offers a good view of Mt. Everest in clear weather. Along the Lhasa - Katmandu road, New Tingri is 370 km from Katmandu, Nepal, and 570 km from Lhasa. Both of these cities are served by modern airports. About 30 km northeast of New Tingri and less than 20 km from the main road, the land rises to a maximum height of 6100-m; this is "Sheka". The Chinese report that the site is accessible via an unimproved road. Nearby (50 km northeast of New Tingri) the main highway crosses Jia Tsuo La; at 5220-m, this is the highest point on the Lhasa - Katmandu road, although it is just one of three passes of over 5000-m elevation on this highway.

Sheka is located at about 28° 40' N latitude and 87° 26' E longitude. At 6100-m the barometric pressure is about 480 mb (i.e. at an atmospheric depth of about 490 g cm^{-2}), or less than half an atmosphere. In the Himalaya mountain range 100 km to the south, the snow line is at about 6300-m. The winds, which carry moisture from India and Nepal, drop much of this water vapor in crossing the Himalayan mountain chain, so that Sheka is relatively dry. The average annual precipitation is 315.8 mm and the average temperature is 2.5° C. There are an average of 7.5 days per year when it snows, and an average of 3326.5 hours per year of sunshine.

3 Other Sites:

From the maps of this area, it is seen that there are other areas of high elevation close by; 5 sites with elevations between 6200 and 6500-m are identified on the map within 30 km of the highway between Jia Tsuo La and Lalung La, which is another pass of over 5000-m on the road to Katmandu 154 km west of New Tingri. From the very sketchy information on these maps, it is certainly not clear the extent to which any of these sites would be suitable for a research station; they may be steep, rocky peaks. Much better

charts or an aerial survey would be needed to identify a site which would be useful for the scientific observations which have been discussed.

4 Research Areas:

The original motivation for pressing for the establishment of a new, higher elevation research site was to carry out cosmic ray research in areas which have been exploited at other high altitude sites. These include the study of strong interactions using emulsion chambers, where the higher elevation would increase the rates and reduce uncertainties from interactions above the detector. Another area was the study of primary gamma rays, taking advantage of the shallower atmospheric depth to study with air showers energies in the gap between air shower arrays and air Cherenkov telescopes. It may be true that in both cases the argument for a higher station is weaker now than earlier. In the case of gamma ray astronomy, new installations such as MILAGRO (in the U.S.) and the Argo RPC array at Yang Ba Jing, together with newer and larger Cherenkov arrays, may comfortably bridge this energy gap around a few TeV. And in the study of high energy interactions, experiments such as FELIX at the LHC may cover the physics previously explored intensively only with the cosmic ray emulsion chambers. However the FELIX proposal has been rejected (for the immediate future), and much still remains unknown in the area of gamma ray astronomy. Were such a high altitude station established, it would surely be used by members of the gamma ray and emulsion chamber communities as well as other cosmic ray research groups.

Other research areas which would profit by the low atmospheric water vapor overburden (the falloff of water vapor with altitude is much faster than the falloff of barometric pressure) would include infrared astronomy and perhaps higher resolution studies of the 2.7K cosmic microwave background radiation. And (as the Chinese have anticipated) there is a wealth of meteorological information to be collected and studied, as well as unusual biological science. In this context, a U.S. National Science Foundation 1997 ‘‘Announcement of Opportunity” solicited proposals on the topic of ‘‘Life in Extreme Environments”; such studies at Sheka would surely qualify!

5 Logistics:

The new information in this discussion is not only the identification of a specific site above 6000-m but also the possible access to this site by road. Earlier discussions had assumed that the only access would be by air. This favorably alters the economics and logistics of establishing such a station; the transport of heavy equipment, e.g. diesel-electric power generators and their required fuel, becomes much simpler. It is still probable that scientists in residence would require pressurized environments for habitation, for laboratories (data collection, equipment repair, etc.), and meetings. Outdoor activities such as setting up, adjusting, and maintaining detector systems, might require supplemental oxygen. And transport of personnel to and from such a station would, as discussed in earlier papers, still be preferable by air. Overall the costs per man-month at this high altitude station would probably be closer to maintaining staff at the South Pole than to operating a typical mountain laboratory, such as at Chacaltaya, Tien Shan, or Norikura.

6 Other Cosmic Ray Research Stations

It may be useful to note a roster of the existing global high altitude cosmic ray research stations; these are summarized in the table below. Some of these may no longer maintain active research facilities. Most of the values of elevations and atmospheric pressures (in terms of grams per cm^2 of overburden) were taken from reports in past ICRC proceedings.

Table I. High Altitude Cosmic Ray Research Stations

Station Name	Host Country	Elevation	Atmospheric Pressure
Kamba La	Tibet	5450 m	520 g/cm^2
Mt. Chacaltaya*	Bolivia	5220 m	540 g/cm^2
Pamirs	Tadjikistan	4380 m	596 g/cm^2
Yang ba Jing*	Tibet	4300 m	606 g/cm^2
South Pole*	Antarctica	2835 m	650 g/cm^2
Mt. Fuji	Japan	3776 m	650 g/cm^2
Tien Shan*	Kyrgyzstan	3250 m	680 g/cm^2
Mt. Aragatz*	Armenia	3200 m	690 g/cm^2
Mt. Norikura*	Japan	2700 m	740 g/cm^2
Ootacamund*	India	2200 m	800 g/cm^2
La Palma*	Canary Is.	2200 m	800 g/cm^2
Gran Sasso*	Italy	2005 m	810 g/cm^2

*Electric power on site

7 Conclusions

It is, to these authors, inevitable that such a station will be established in the future. The only questions are when, by whom, and under what arrangements. Every discussion agrees that this should be an international undertaking, but (in view of the location) the East Asians will probably assume the organizational responsibility. Cosmic ray physics will surely benefit when such a station becomes a reality.

8 References

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