# A case study of rolling down of vehicles downhill Kala Dungar

*Field Investigation report*

**(25-12-10 to 31-12-10)**

***Investigation team***

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# A case study of rolling down of vehicles downhill Kala Dungar

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## The Phenomenon

On December 24, 2010 afternoon, a resident of Kala Dungar hill area reported experiencing vehicles rolling down the hill in natural gear. In the evening collector Kachchh also went there and experienced the same. He reported that in about 4 km Stretch of the road, vehicle rolls down in neutral gear. The vehicle attains a speed of 70-80 Km/hr and cross over the bumps. The area is 60 km North of Dordo village (the venue of Rann Utsav), 08 km North of Khavda town, near Dawda and Dinara Villages ($23.89^0$& $69.75^0$E). The S&T Dept. and GSDMA desired ISR to investigate. The ISR team with IITk started the following Investigation from 25.12.2010

1. Slope Measurement.
2. Seismicity and Geology
3. Checking Speed of Vehicles
4. Gravity
5. Magnetic (carried out on 29th & 30th Dec. 2010)

## TOPOGRAPHIC OBSERVATIONS

The Pachchham Island in Kachchh rift basin shows unique topographic developments. The slope of Island has been measured using Real Time Kinematic (RTK) instrument. Survey has been done after establishing one RTK base and cross profiling has been done along three roads in rover mode (Fig. 1). The RTK data have been analyzed using SKI-PRO software and DEM analysis have been done by data processing software Micro-DEM and Global-Mapper-10 (Fig. 2). Towards north of the Island north facing scarp is clearly visible and marked by Island belt Fault. The south facing topography of the area show average $32^0$ slopes towards WSW direction ( Fig. 2 and 3). The drainage network of investigated area has been mapped by LISS-III satellite data using GIS software. Stream orientation analysis was carried out in order to study the effect of slanting on the drainage. Streams originating on the SSW slope of the northwestern structural hills and SSE slope of northeastern hills (Fig. 4). A rectified drainage map was prepared by joining the two end points of drainage links. Equal distribution pattern of slope towards SSW and SSE direction shows structural control.

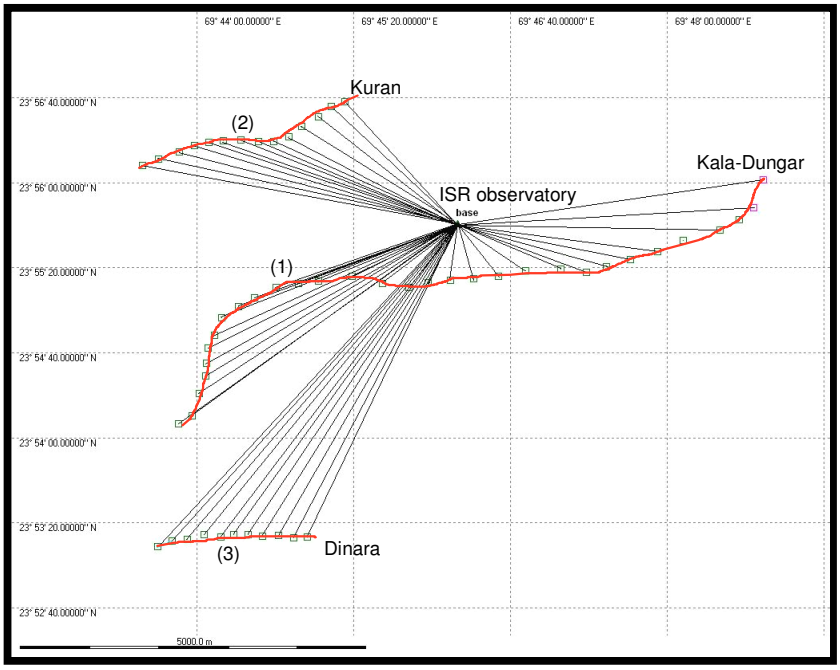


Fig. 1 RTK rover points with reference to the RTK base station for precise survey

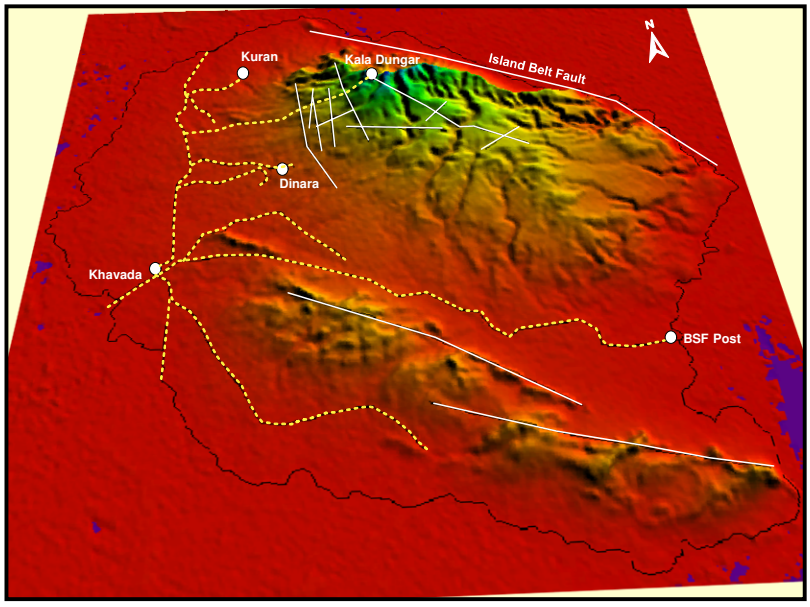


Fig. 2. DEM of Pachchham Island showing topographic signature

The topographic profiles (Fig. 3) clearly indicates that the topography is sloping towards WSW direction. The topographic gradient in and around investigated area varies place to place. The slope of profile one is almost $32^0$ towards WSW where as profile two and three shows $2^0$-$7^0$ slope towards westward.

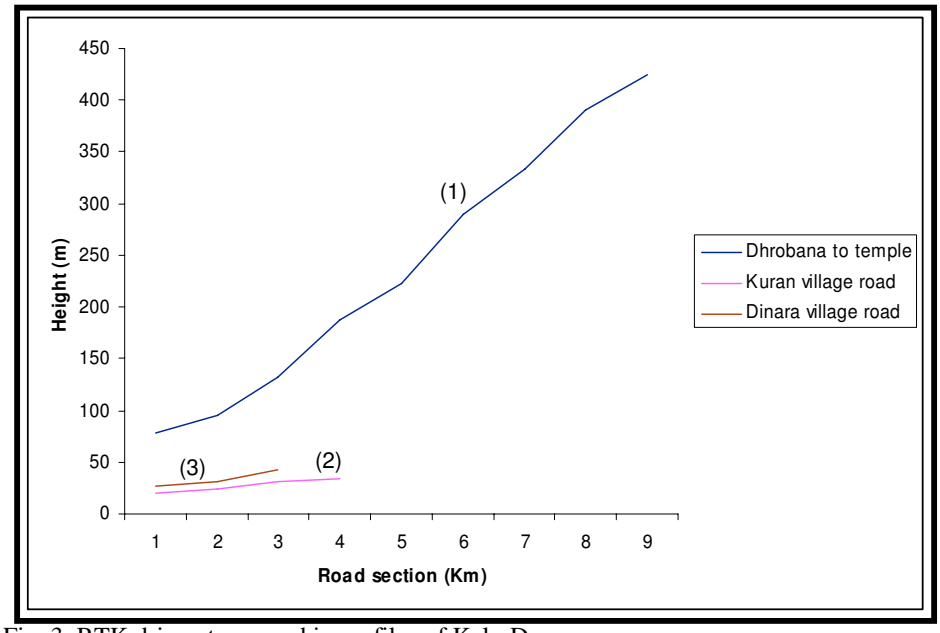


Fig. 3 RTK driven topographic profiles of Kala-Dungar area

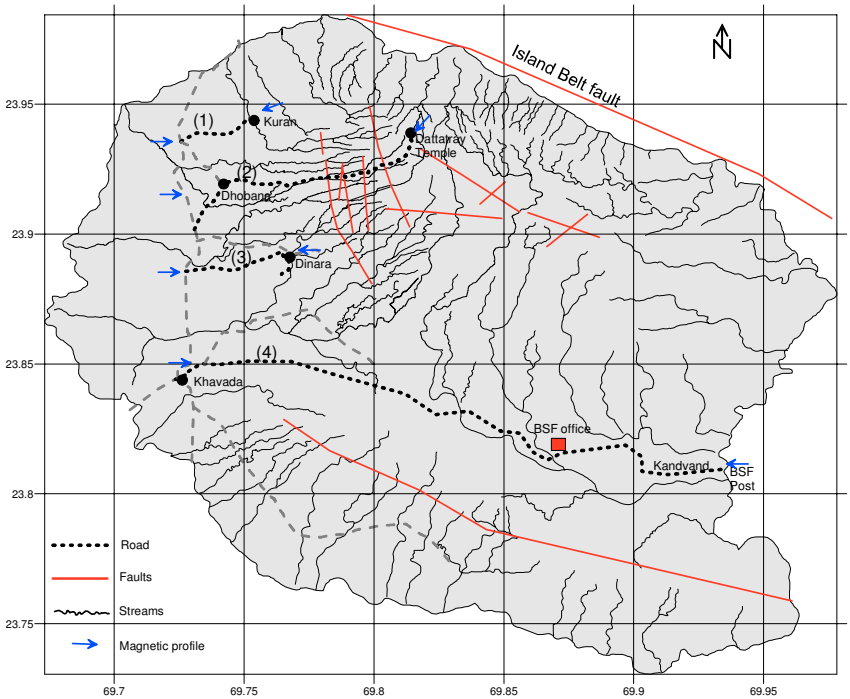


Fig. 4 Location and drainage map of the area shows signature of faults and magnetic profile direction

## GEOLOGICAL AND STRUCTURAL OBSERVATIONS

The Kachchh rift basin was evolved due to sequential rifting and repeated movements along Precambrian tectonic trends and it took place in relation with the Indian plate's northward drift after the break up from the Gondwanaland in the Late Triassic-Early Jurassic (Norton and Sclater, 1979; Biswas 1982, 1987, 1991; Boccaletti et al., 1988). The 3000m thick sedimentary successions of Kachchh rift basin was deposited between Late Triassic to Lower Cretaceous (Biswas, 1981; Singh et al., 1982). The sedimentary units in the basin are characterized by predominantly siliciclastic with the carbonate sediments. The Tertiary rocks are overlying unconformably on the Mesozoics in the Mainland area is marked by Kachchh Mainland Fault (KMF). Similar phenomenan have been reported south of Pachchham Island (Biswas, 1982). Kachchh rifting was initiated in the Late Triassic as indicated by continental Rhaetic sediments in the northern part of the basin (Koshal, 1975). The basin is characterized by highlands, which are the areas of uplift and the plains, which are the basins between the uplifts. The uplifts are oriented E-W along basinal faults (Biswas, 1987). Such as Bela, Khadir, Pachchham. The uplifted islands platform slopes towards the southwest. The platform features a Median High across parallel fault ridges and demarcates the hinge of the basin in the Late Jurassic-Early Cretaceous time.

The northern limit of IBF is marked by Island Belt fault (IBF). The faulting is indicated by steeply dipping beds of the forelimbs of drag-folds and the imposing escarpment facing north (Fig. 5a). At the foot of the northern scarp of Pachchham, Island near Kaladungar hills carbonaceous sand-stone beds dipping $60^0$-$80^0$ to the north in to the Rann is exposed. Whereas towards south of Island beds are gently dipping $18^0$-$20^0$ to south. The high erratic dip along the margin of the uplift bordering Rann indicates presence of fault. The faults appear to have been dislocated by NE-SW strike-slip fault. The central part of Pachchham Island is controlled by N-S to NNW-SSE and NE-SW to E-W trending faults. Near Kaladungar hill (69.81111E and 23.93006 N) gently south dipping E-W striking reverse fault have been observed. The tectonic movement along this fault has resulted steeping of topographic relief towards south (Fig. 5b).

The investigated area has been ruptured by N-S trending faults (Fig. 5c). Near the fault zone the rock units are highly fractured, 2-3 sets conjugate joints were clearly visible in the bedrocks. Joint one (J1) is dipping $76^0$ towards N70E and Joint two (J2) is dipping $78^0$ towards S70E. The intensity of joints and surface fractures increases towards forelimb of fault (Fig. 5d). The pebbles within the lithounits are elongated towards NW direction. NW elongation of pebble indicates NE-SW compression in the area. The tectonic movement along this fault has resulted in the development of strath terraces and incision of channel towards up throw block side. Stream flowing across the fault are deflected due to movement along this fault (Fig. 4)

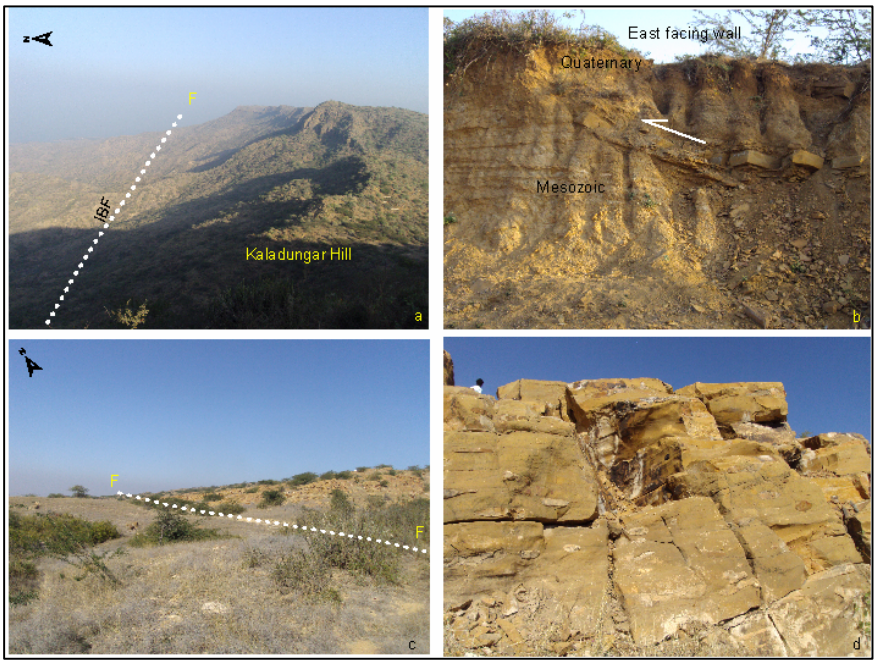


Fig. 5. Field Photograph shows (a) trace of IBF, (b) Presence of gently dipping fault in Kala-Dungar area, (c) trace of N-S trending fault (d) Two sets of Joints are clearly visible in the rock near fault zone and pebbles are elongated towards principle axis

The Gora-Dungar hills in the southern extension of Pachchham Island are marked by sub-vertical fault. The conjugate folded and fractured features in this region points that the Gora-Dungar fault is a strike-slipe fault. The marginal flexures and oblique folde related to subsidiary fault present a complicated fault and fold pattern of the Gora-Dungar uplift.

## GEOPHYSICAL OBSERVATIONS:

### Seismicity

The area has significant faults around it (Island belt fault 12 km North, Banni fault 20 km South and a small N-S trending fault of 200m length abutting against Kala Dungar Hill.The rock beds are dipping $18^0$ towards N $45^0$W. An area, about 30 to 50 km SE of Khavda is experiencing earthquakes from 2005 onwards. The area has seismicity more so from 2009. During 2009, some 100 small shocks and one magnitude 4.5 earthquake on 28 Oct. 2009 occurred 20 km SE of Khavda, Kachchh (Figs. 6a&b).

However, Kala Dungar Hill area itself has not been the seat of significant earthquakes.

**Table 1: Detail of Seismicity from 2001 to 2009 in Khavda region.**

| | 0.5 – 1.9 | 2 – 2.9 | 3 – 3.9 | 4 – 4.9 | Total(203) |
|---|---|---|---|---|---|
| 2001 | 2 | 2 | 2 | 1 | 7 |
| 2002 | 1 | 1 | | | 2 |
| 2003 | | 1 | 1 | | 2 |
| 2004 | | 1 | | | 1 |
| 2005 | | 4 | 11 | 1 | 16 |
| 2006 | 6 | 13 | 2 | | 21 |
| 2007 | 5 | 10 | 4 | | 19 |
| 2008 | 11 | 11 | 5 | | 27 |
| 2009 | 67 | 19 | 6 | 1 | 93 |

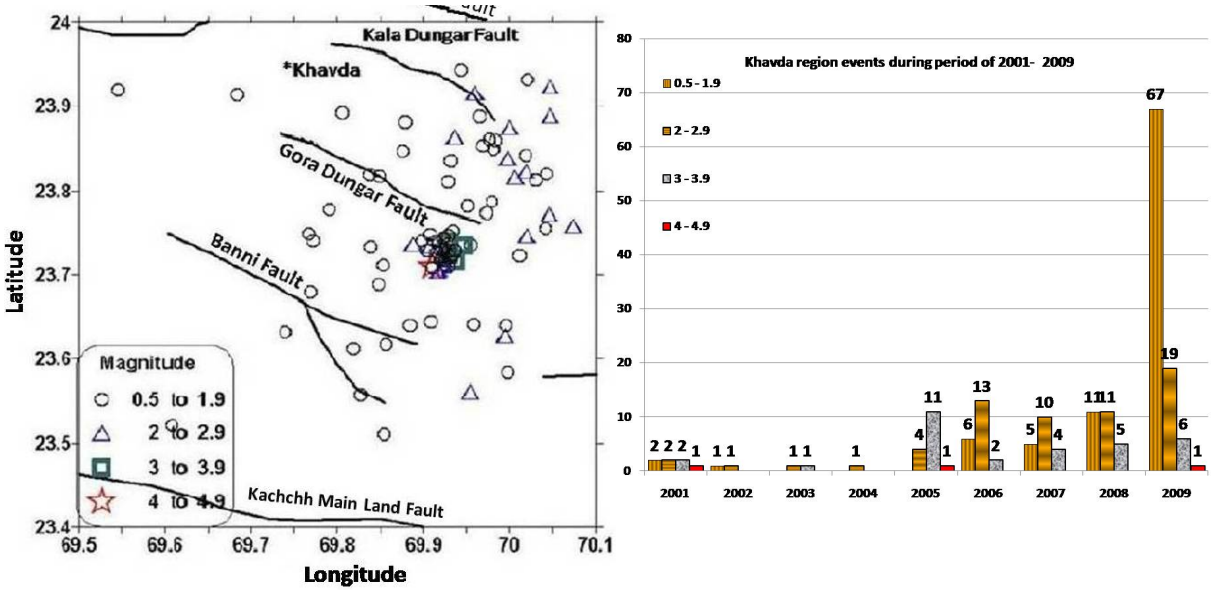


**Fig 6 . (a)**Shocks of Magnitude 1 to 4.5 during 2009 near Khavda, (b) Histogram showing number of Earthquake of Magnitude greater than or equal to 1

## Magnetic and Gravity Survey

The total magnetic field in Pachchham Island was recorded at about 1 km interval using Proton Precision Magnetometer (PPM) towards WSW-W direction to verify the gravity picture. The intensity of magnetic field in Pachchham Island ranges from 36,000-38,000 with 1 gamma accuracy level (Fig. 7). The Magnetic picture of the region has been generated using surfer 9.6

software. The values at different points are mentioned within parentheses and values gradually change in between. The variation is normal and comparable with the measurements done at other places in Kachchh. In Wagad area a variation of 80K.gamma/km was measured, while in Kala Dungar area the variation is maximum 50 K.gamma/km.

1. Khavda (37,261 K.gamma) – Kala Dungar (36,858 K.gamma): 9 km Length (In 2 km stretch of the road where maximum slope and speed of vehicles is observed the variation is negligible, being only 97 K. gamma.
2. 3 km N of Khavda (36,897 K.gamma) – Kuran (36,812 K.gamma): 4 km Length.
3. 2 km N of Khavda (36,999 K.gamma) – Dinara (36,951 K.gamma): 5 km Length
4. Khavda (36,872 K.gamma) – Khandvan (37,143 K.gamma): 23 km Length.

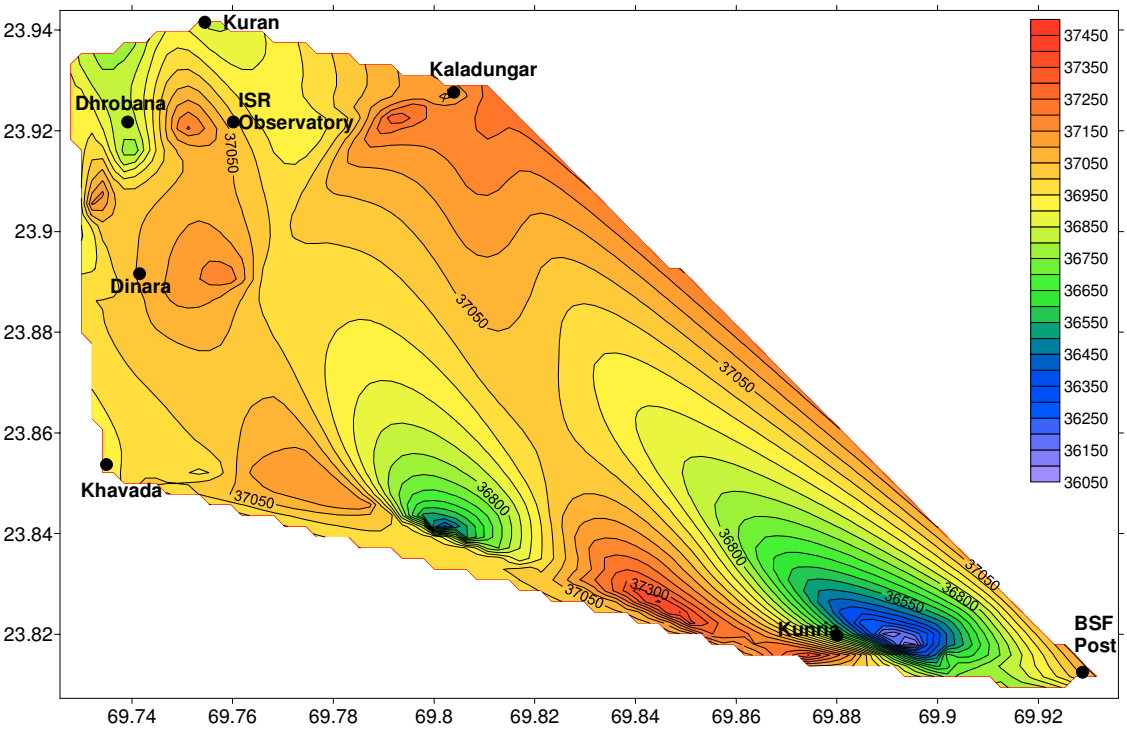


Fig. 7 Total magnetic field intensity map of Kala-Dungar and adjoining areas.

We do not found abnormal values of total magnetic field in the region. Near Kuran, Dhrobana and Kunaria village the magnetic intensity is very low which indicate fracturing of basement rocks. The higher magnetic intensity might be due to inflexible of lithounits (Fig. 7). In between Dinara and Kala-Dungar hill almost N-S trending low magnetic field have been identified which indicate presence of N-S fault.

The Gravity profiles were taken along three E-W roads around Kala-Dungar area. The Gravity value have been studied using using CG-5 gravity meter at about 1 km interval. The gravity contour have been generated at 1mgal interval level using surfer 9.6 software to understand variation in Gravity. Towards the hill top the gravity value is very low might be either due to low density or Kala-Dungar Fault. Gradual increase in gravity have seen towards south. The increase of gravity towards downhill is observed to be 10mgl which is normal along the hill slope (Fig 8)

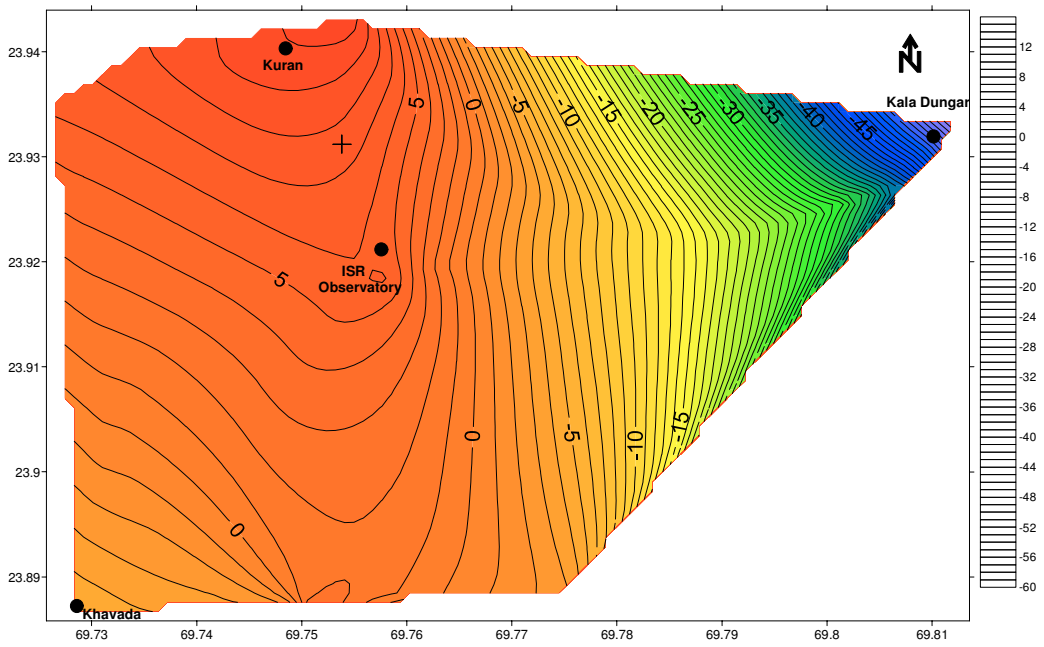


Fig. 8 Gravity Picture of Kala-Dungar area

## Conclusion:

Topographic and Geological and Geomorphological data analysis does not show any active fault signature in the region. Total magnetic field in the region is controlled by lithological units. Variation of magnetic field at 1 km interval is about 50 K gamma which indicate normal behavior total magnetic field. The gravity anomaly of the area shows 10 mgl differences towards down hill at 9 km length. Gravity and magnetic picture does not shows signature of magnetic material beneath the surface. On the basis of above observation it can be concluded that the movement of vehicles along the slope is due to westward facing topography. The hurling down of vehicles is normal slope phenomenon.