

Vein Geometry Around Bhuj (Gujarat, India)



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Abstract The Bhuj area (Kutch, Gujarat, India) is a good and rather unexplored place in terms of structural geology. This is despite the Kutch region has been studied in detail for palaeontology, sedimentology and stratigraphy. We report three morphologies of vein sets of quartz within the sandstone country rock. The area shows a good possibility of conducting fieldwork with B.Sc. students.

1 Introduction

Veins are joins that are filled up by secondary minerals and can form by fluid overpressure see Passchier and Trouw (2005), Bons (2010), Bons et al. (2012), Mukherjee (2014a, b, 2015), Fossen (2016). Mukherjee et al. (2019) and Ghosh and Mukherjee (2020) as introductory reading materials on vein geometries.

Figure 1 is a recent summary of tectonic elements of the Kutch region.

2 Veins

Three types of quartz vein patterns within sandstone are noteworthy: (i) X-pattern or acute angle-obtuse angle intersection pattern (Figs. 2, 3, 4 and 5), (ii) high-angle intersection pattern (Figs. 6 and 7), and (iii) vein displaced/folded against or near another vein (Figs. 8 and 9).

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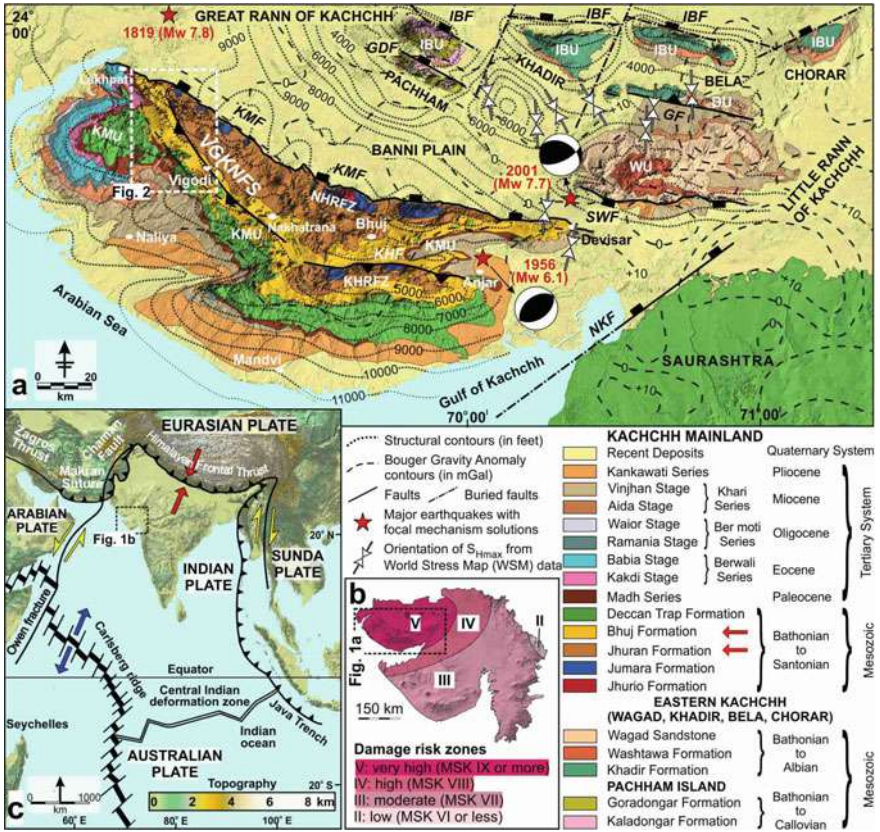


Fig. 1 The Kachchh Rift Basin, reproduced from Shaikh et al. (2020). The study area Bhuj is shown. White inward-pointed double arrows: S_{HMax} , black dotted 1584 lines represent structural contours with 1000 feet interval, Black dashed lines: Bouguer Gravity Anomaly contours in mGal, Red stars: major seismicity, IBF: Island Belt Fault, GDF: Gora Dugar Fault, GF: Gedi Fault, SWF: South Wagad Fault, KMF: Kachchh Mainland Fault, VGKNFS: Vigodi-Gugriana-Khirsara-Netra Fault System, KHF: Katrol Hill Fault, NKF: North Kathiawar Fault. IBU: Island Belt Uplift, DU: Desalpar Uplift, WU: Wagad Uplift, KMU: Kachchh Mainland Uplift, NHRFZ: Northern Hill Range Fault Zone, KHRFZ: Katrol Hill Range Fault Zone. Red, blue and yellow double arrows: relative plate motion at convergent, divergent and transform-fault boundaries respectively

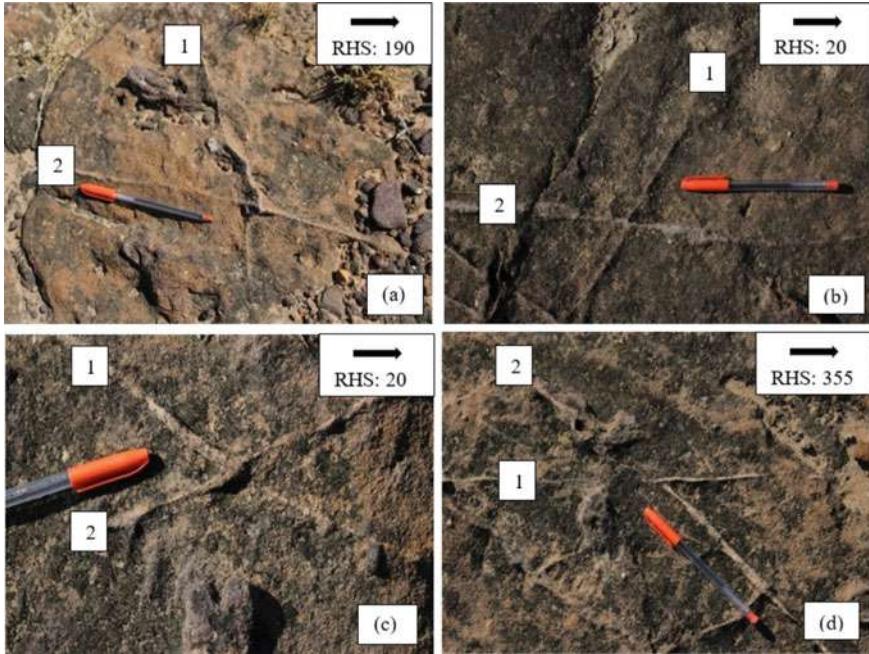


Fig. 2 “X-pattern” of sub-vertical veins in horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 85°. Strike of vein-2: 10°. **b** Strike of vein-1: 315°, Strike of vein-2: 20°. **c** Strike of vein-1: 330°, Strike of vein-2: 25°. **d** Strike of vein-1: 355°, Strike of vein-2: 40°

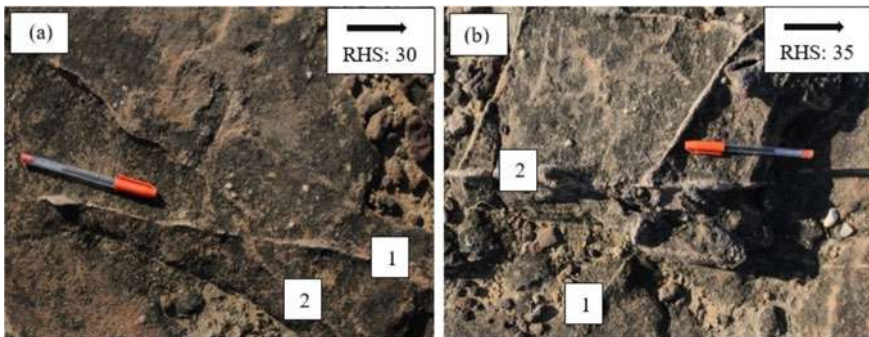


Fig. 3 “X-pattern” of steeply-dipping to sub-vertical veins in horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 355°. Strike of vein-2: 30°. Dip: 70°. **b** Strike of vein-1: 345°, Strike of vein-2: 35°. Dip: 82°. **c** Strike of vein-1: 330°, Strike of vein-2: 25°. Dip: 80°. **d** Strike of vein-1: 225°. Dip: 80°. Strike of vein-2: 170°. Dip: 85°

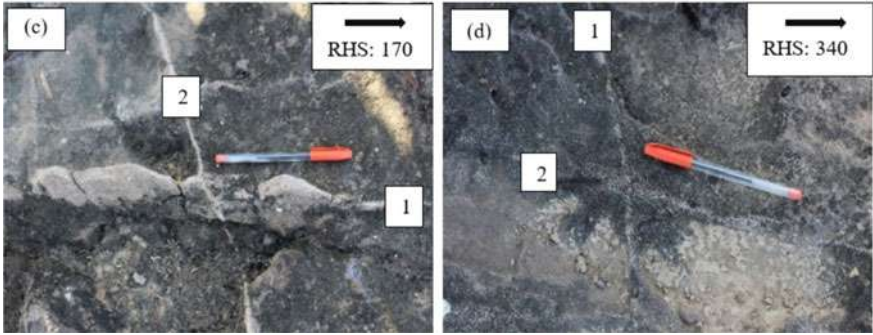


Fig. 3 (continued)

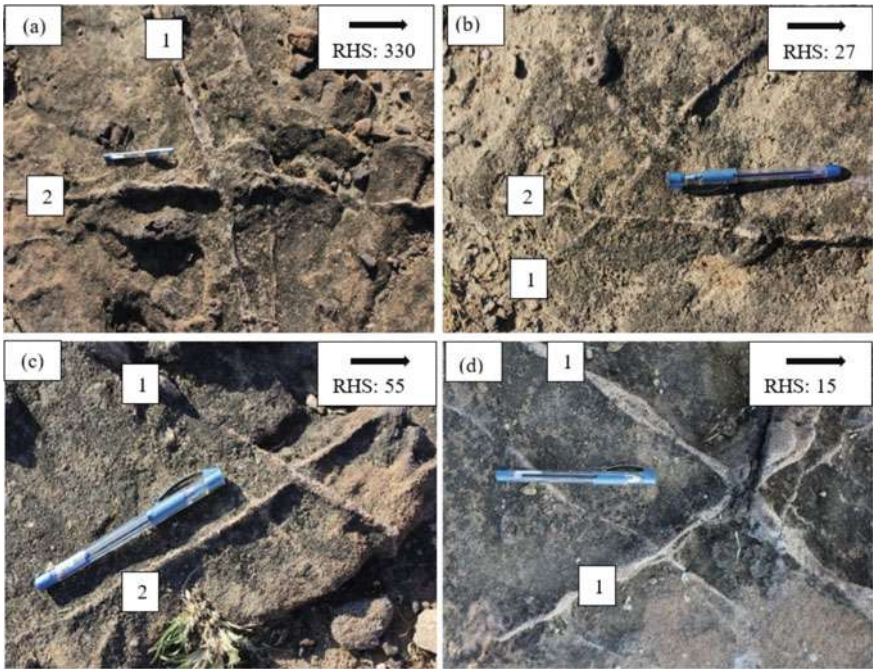


Fig. 4 “X-pattern” of steeply-dipping to sub-vertical veins in horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 40°. Dip: 86°. Strike of vein-2: 330°. Dip: 88°. **b** Strike of vein-1: 340°, Strike of vein-2: 27°. **c** Strike of vein-1: 55°. Dip: 86°. Strike of vein-2: 335°. Dip 88°. **d** Strike of vein-1: 350°. Dip: 86°. Strike of vein-2: 40°. Dip: 82°

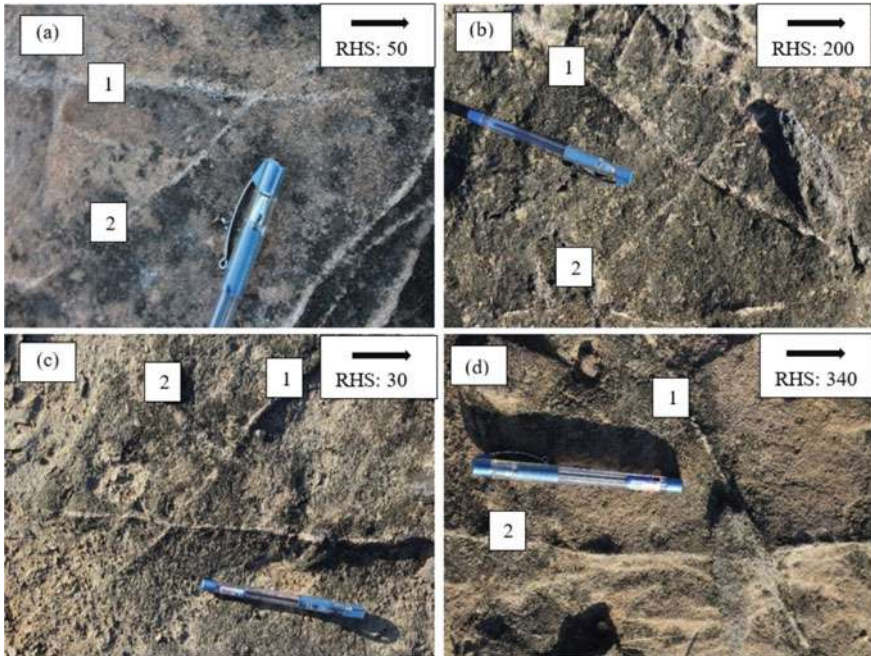


Fig. 5 “X-pattern” of steeply-dipping to sub-vertical veins in a horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 50°. Strike of vein-2: 10°. **b** Strike of vein-1: 50°, Strike of vein-2: 10°. **c** Strike of vein-1: 230°. Strike of vein-2: 335°. **d** Strike of vein-1: 30°. Strike of vein-2: 340°

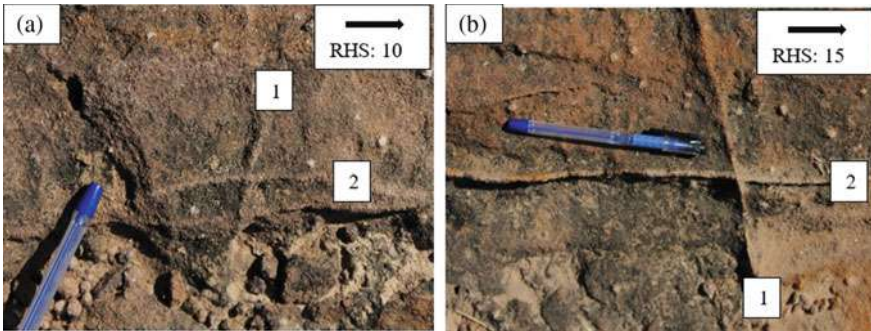


Fig. 6 High-angle intersection pattern of veins a horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 292°. Strike of vein-2: 10°. **b** Strike of vein-1: 255°, Strike of vein-2: 15°. Dip of both the veins are 90°. **c** Strike of vein-1: 230°. Strike of vein-2: 335°. **d** Strike of vein-1: 30°. Strike of vein-2: 340°

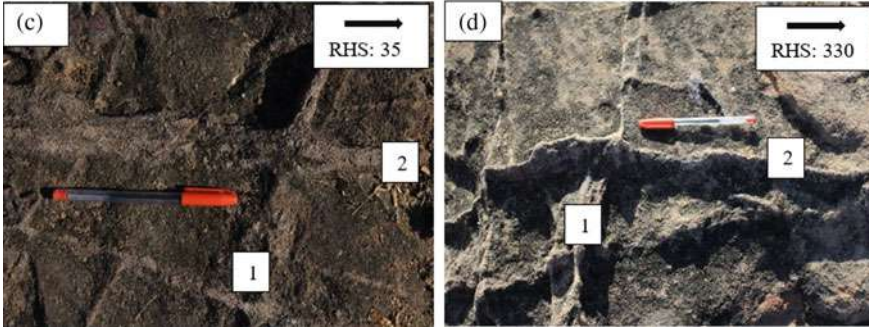


Fig. 6 (continued)

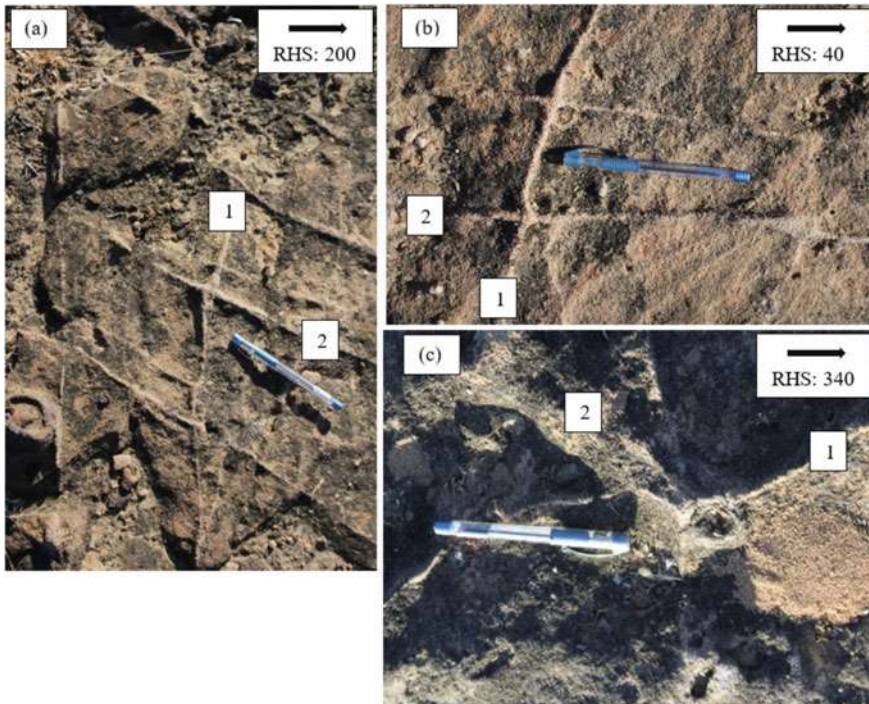


Fig. 7 High-angle intersection pattern of veins a horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 310° . Dip: 90° . Strike of vein-2: 200° . Dip: 84° . **b** Strike of vein-1: 320° . Dip: 87° . Strike of vein-2: 40° . Dip: 88° . **c** Strike of vein-1: 340° . Dip: 82° . Strike of vein-2: 80° . Dip: 85°

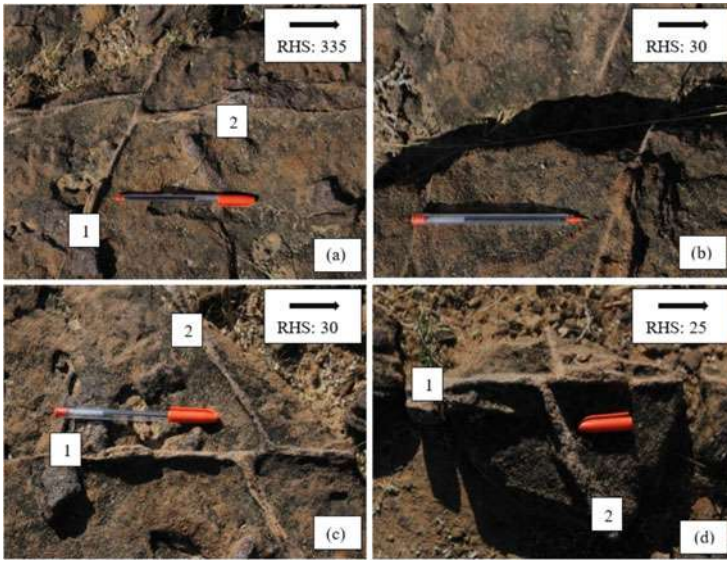


Fig. 8 Vein displaced/folded against or near another vein. Horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 210°. **b** Strike of vein-1: 330°. **c** Strike of vein-1: 210°. **d** Strike of vein-1: 140°



Fig. 9 Vein displaced/folded against or near another vein. Horizontal outcrop of sandstone along Kodhki Road. **a** Strike of vein-1: 160°. Dip: 80°. Dip direction: 70°. **b** Strike of vein-1: 160°. Dip: 85°. **c** Strike of vein-1: 25°. Dip: 70°

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