## Abstract

The cliffs above the public beaches of the Conero Riviera between Ancona and Portonovo, Italy, are comprised of sedimentary rocks and are subject to copious rainfall and occasional earthquakes. The area has experienced large-scale landslide events, from Portonovo's 14th century landslide to Ancona's more recent 1982 landslide. Though these events have been studied at length, there are no studies on this region's risk of future landslides. Based on the historical and geological evidence, it is important that the Ancona coastline be assessed for landslide risk. This study aimed to determine the role of geologic structures in the area near these two historic landslides using kinematic analysis as well as structural and stratigraphic field data collected between the Ancona shipyard and the southernmost accessible beach of Monte Conero. We collected data from within several different rock units and observed distinct patterns of jointing, faulting, and bedding along the coast. Some of these structures show risk of planar and wedge failure. There is evidence of recent rockfalls and landslides, all of which were smaller than the two historical slides. We conclude that the Conero Riviera coastline is at risk for future landsliding and rockfall, making it dangerous for beachgoers.

## Introduction

The cliffs above many public beaches in and around Ancona, Italy, show clear signs of landslides and landslide risk yet. The area of study, the Conero Riviera spanning from Ancona's shipyard to Monte Conero is located in a region with a strong history of earthquakes, heavy rainfall, and large landslides (Figure 1).

The area just north of this field site underwent a massive landslide in 1982 (Crescenti et al, 2005). This event occurred along 1.7 km of the coast, affecting a total of approximately 3.4 $km^2$ of the land (Crescenti et al, 2005). The sediments affected by this slide were mid-Pliocene marly clays interbedded with silts and sands, all overlain by Pleistocene silty/marly clays with stratified sand layers (Crescenti et al, 2005). Also, in Portonovo, Italy, just south of Ancona, there was another massive slide in the early 14th century (Montanari et al, 2016). This slide was characterized by the movement of five million cubic meters of the Scaglia Rossa, Marne a Fucoidi, and Maiolica limestone units from up to 400 meters elevation (Montanari et al, 2016).

The lithology of the region is primarily limestone with a small stretch of alternating gypsums and marls (Figure 2). The coast was split into eight analysis regions based on bedrock composition and the orientations of structures (Figure 3). For sections 1a-d, the cliffs are comprised of the Miocene units of Bisciaro limestone overlain with Schlier limestone. The weathering for 1a-c, which is characterized by the formation of friable clumps of rock from silt sized up to cobble sized, pervades up to 10 cm back from the face of the outcrop into the rock. The weathering affects the Bisciaro unit uniformly. The Schlier is comprised of beds of alternating strength, so it weathers differentially with ~0.75 m difference between the layers that are ½ m thick(Figure 4). In section 1d, the jointing is dense, and this section is transforming into a C horizon soil rather than weathering away from the outside in as seen in section 1a-c. South of the Schlier/Bisciaro units in section 2, the cliffs are comprised of Colombacci marls, another Miocene unit. The weathering of this unit is uniform and is similar to the weathering at 1d, also creating a C horizon soil. The Gessoso-Solfifera unit, section 3, consists alternating beds of Miocene gypsum and marly shales. Some of the beds contain microcrystalline chalk laminae. The gypsum weathers away first, leaving up to 3 meters of steeply dipping marly shale beds jutting out of the base of the cliff. Further south in section 4, closer to Portonovo, the Schlier and Bisciaro outcrop again. The fifth and final segment of this analysis is Monte Conero. This region is mostly Maiolica limestone (lower Cretaceous) with a small outcrop of Scaglia Rossa limestone (late Cretaceous-middle Eocene) and chert beds at the northernmost end of this section. Weathering in these units was superficial rather than pervasive, consisting primarily of slight surface discoloration.

In the region of study, there are clear indications of frequent small-scale landsliding such as fallen boulders and gravel, fresh detachment faces, and piles of fallen soil and debris. Thus, this area is a prime location for studying landslide risk. Further, while the regions of past large slides have been studied, no research has been done to determine if the Riviera is at risk for a massive sliding event comparable to the two mentioned above. This study aimed to discern the magnitude and nature of the landsliding risk of the region in an effort to predict futures slide locations and styles.

To this end, we explored the idea that structural data can be used to determine whether a particular stretch of coast within the field area is at risk of landslides. In addition to structural effects, the effects of stratigraphy on risk magnitude was also examined. Historical slides and rock falls were used to characterize the style of landsliding that the area is at risk of. Standard slope analyses and the characteristics of the rock units were used in resolving the question of how structurally sound each section of coastline is. Structural and stratigraphic analysis was chosen for this project because the field area is highly populated with structures such as joints, bedding, faults, and stylolites.

## Methods

Fieldwork was conducted from June 24-July 21, 2016. The process began with the examination of Google Earth maps, bedrock maps, and historical aerial photography obtained from Ancona's cartographic office. From this imagery, we determined the location of slides that occurred in recent history, paths to be able to access these locations, and the extent of the field area. The study area spanned from 379946.39 m E, 4831392.06 m N to 389104.68 m E, 4822365.39 m N (Figure 3). The data collection process consisted of working along the base of this stretch of cliffs, covering as much of the coast as could be reached by foot. We accessed two beaches and several photographic vantage points by boat.

Using a Brunton compass, we obtained and recorded slope, joint, bedding, fault, slickenside, and stylolite measurements. These measurements were analyzed on stereonets using the program Stereonet3D. The density of the fractures and stylolites as well as the depth to which weathering affected the different rock units were also recorded. Whenever evidence of past landsliding was present (such as fallen debris or detachment scarps), the nature of the slide (rockfall versus landslide), dimensions, and detachment location of each slide was noted. Since many of the slides detached from too far up the cliffs to see from the vantage point of the beach and since many of them happened over the course of many years, Google Earth historical images were used to assist in this process where field data was insufficient. At each new rock unit, hand samples of the bedrock were taken for future reference. The European Marine Observation and Data Network (EMODnet) was used to obtain bathymetry data (http://www.emodnet.eu/).

Wyllie and Mah's kinematics analysis served as the basis for determining the risk of rock failure (Wylie et al, 2004). This process gives criteria for determining three different types of failure characterized by different orientations of planar failure surfaces. The three types are plane failure, wedge failure, and topple failure (Wylie et al, 2004). The criteria for determining these failure depend on the slip envelope of the rock; for this analysis, we used a slip angle of 30 degrees. Tables 1 and 2 contain all the criteria for each form of failure.

Planar failure can occur when the following conditions are met: (1)  the dip direction of the planar feature in question is within 20 degrees of the dip direction of the slope face and (2) the dip angle of the feature is greater than the slip envelope but less than the slope-face dip angle (Wylie et al, 2004). Both of these conditions are met when the feature is oriented such that its pole falls in the shaded region in Figure 5. The steeper the dip of the plane, the greater the risk of failure (Wylie et al, 2004).

The next form of failure is wedge failure (Wylie et al, 2004). This form of failure deals with the stability of wedges of rock formed from the intersection of two planes of weakness (Wylie et al, 2004). In this case, the orientation of this intersection line is considered instead of poles to the planes (Wylie et al, 2004). If (1) the plunge of this line falls between the slip envelope and the slope’s dip angle and (2) the trend of this line is within 20 degrees of the slope’s dip direction, the wedge is at risk of falling (Wylie et al, 2004). The region that the line must fall within to meet these criteria can be seen shaded in Figure 6. The steeper the intersection line, the higher the risk of failure (Wylie et al, 2004).

Topple failure occurs when steeply dipping planes of weakness cause entire columns or sheets of rock to topple over. For this type of failure, (1) the dip direction of the plane must be within 10 degrees of that of the slope face, and (2) the sum of the slip envelope and the complement of the dip angle must be less than the dip angle of the slope face (Wylie et al, 2004). The shaded area in Figure 7 shows where the poles to the plane must fall for this type of failure.

## Results

The mean orientations and density of structures for all locations can be seen in Table 3. Six out of the eight regions are at risk of both planar and wedge failure, and one is at risk of planar failure alone. In total, seven out of eight regions exhibit risk of kinematic failure induced landsliding or rockfall. Figures 8a-8m show each region's form(s) of failure and which structural feature is forming the failure planes.

### Section 1a and 1b

These areas had two sets of pervasive joints. Several instances of block falls caused by the two joint families were found (Figure 9, Figure 10). Two types of past landsliding can be seen in this area: falls of large boulders and cobbles from various heights on the cliff and low volume landslides of sand to cobble sized clasts.

### Section 1c

This section was characterized by a lack of homogeneity in jointing. We found a higher concentration of faults here than elsewhere in the Schlier/Bisciaro. The landsliding in this area was largely small landslides with few large blocks falling.

### Section 1d

The jointing pattern becomes similar to the intersecting joints pattern seen in 1a, but with much greater fracture density. There was also a landslide which detached from approximately 100 m elevation on the cliff face. This slide was comprised of a mud matrix with some limestone pebbles and gravel. It spanned 125 m wide at the toe and 135m around the perimeter of the toe. It appeared to be recent since it contained undecomposed plant matter and since it had not yet been compacted.

**Section 2**

There were two more landslides similar in style to the one at 1d, though smaller and less recent. They were roughly 50 and 75 meters wide at the toe. There are two families of joints which are oriented for wedge failure. Section 2 is also similar to section 1 in that the joint spacing is narrow.

**Section 3**

This section's planar features are bedding and three faults. None of these features are oriented in a way that is suitable for any type of failure. The bedrock is only visible at the bottom of the cliffs as the top is covered by debris.

**Section 4**

While the bedrock is the same as section 1, the bedding orientation changes. The jointing lacks clustering. They dip between 50-90 degrees. The jointing is oriented such that this area is prone to plane, wedge, and topple failures. We found large planar failure blocks that had detached that were similar to the ones at 1a. There were also several small slides. Like section 3, the bedrock only outcrops at the bottom of the cliff due to the top being covered in debris.

**Section 5**

The bedding here is oriented for plane failure. Tens of square meters of bedding planes are exposed at a time along the slope, creating its shape. A small proportion (less than one third) of the joints and stylolites are oriented for wedge failure. The remains of two large landslides were present.

## Discussion

### Relative landslide risk levels

Based on the number of failure types at each location, locations 1a-d, 4, and 5 are the highest landslide risk regions as they show both planar and wedge failure risk. Within locations 1a-d, 1a and 1d are at higher risk levels than 1b and 1c because a larger total proportion of their joints are oriented for failure than the joints in 1b-c. Locations 2 is at moderate risk level with planar failure risk of its joints. Location 3 has no structures oriented for kinematic failure. Relative landslide risk can be seen in Figure 11.

To further differentiate locations by their relative risk level, additional factors such as landsliding history, weathering patterns, cliff heights, and the density of planes of weakness should be considered. Based on additional factors, locations 3 and 5 appear to be at higher risk than the kinematic analysis alone can indicate.

### Implications of past slides

North of location 5 at Portonovo, there was a historic massive landslide in the early 14th century (Montanari et al, 2016). This slide originated from a much greater height than the slides in sections 1-4 (maximum of 400 m height in Portonovo versus maximum of 85 m in this region), but at a similar height to location 5. It also affected similar limestone rock units rock units (Scaglia Rossa, Marne a Fucoidi, and Maiolica), and location 5 is comprised of Scaglia Rossa and Maiolica. While section 5 only shows risk of planar failure of bedding, the height of

Monte Conero (360-530 m in the region analyzed) combined with its similar composition, its clustering of failure planes, its cleavage, and its close proximity to the 14th century slide are cause for added concern. There are also other detachment scars that appear to be from large planar failures. Thus, section 5 appears to be a larger risk than the kinematic analysis can illustrate alone and should be further inspected using additional analysis that incorporate more than kinematics.

The area just north of the total study area underwent a massive landsliding event in 1982. This slide started at the toe of the slope that failed and worked its way farther inland to fail in one massive slump of land. This is not congruent with the characteristics of slides seen in this field area, which are characterized by relatively small amounts of the cliff crumbling away at a time without directly causing other areas farther inland to slide as well. The bathymetry of the region also does not lend itself to allowing this sort of failure. The slope of the seafloor east of the cliffs out into the sea is too shallow to permit it. The seafloor slopes just under 20° on average based on the EMODnet bathymetric maps, making the rock under the cliffs a low risk zone for underwater slides because this slope is too shallow for structures to form many failure planes. Instead, only the subaerial units of the steep cliffs are prone to failure. Ultimately, it is unlikely a landslide similar to the 1982 slide would occur in this region.

**Future slides**

The style of landsliding at locations 1a-c is similar despite these locations having different orientations of joints. The weathering style of the Schlier layer, which leaves every other bed jutting out of the cliff without support, plays a part in the gravel to boulder sized rock falls which detach from varying heights on the cliffs (Figure 9 and Figure 10). As the weak layers erode away, larger and larger volumes of the strong layers are left jutting out of the cliff side with no underlying support. These areas are prone to rockfall events from any height up the cliffs.

Location 1d and 2 have been more weathered than 1a-c and are partially weathered to C horizon soils. Still, they are each populated by two distinct families of joints. The joints are spaced 8-30 cm apart in section 1d and 10-30 cm apart in section 2. The past slides seen in this area are soil slides rather than rockfalls. Further analysis into how far this soil pervades inland is needed before we can estimate the volume of futures slides at 1d and 2, but future failure should be expected to be landslides rather than rock falls.

Locations 3 is the only location without risk of kinematic failure. The slope above the outcrop, however, is covered in old landslide deposits. It is likely that non-kinematic factors are causing these slides, and this stretch needs further investigation before its risk level can be completely understood.

The landslide that partially covers location 3 also covers the upper part of location 4. While location 4 has planes oriented for both wedge and planar failure, these features are only exposed near the bottom of the cliff. They are not seen further up on the cliff. The current landslide deposit would have to be eroded away entirely to reveal a fresh cliff face before wedge or planar failure could occur from the top of the cliff. The nature of slides in the immediate future will be rockfalls from less than 15m height.

Location 5 shows risk of planar failure along bedding planes. There are detachment scars up to approximately 275m elevation above hundreds of square meters of exposed bedding planes

(Figure 12). While this region is at risk of both planar and wedge failure, the majority of failure planes are oriented for planar failure. Almost all of the bedding planes are oriented for planar failure, while only about one third of the joints and stylolites are oriented for wedge failure. Thus, a planar failure slide is more likely to occur here than a wedge failure slide.  This area is susceptible to cobble to boulder sized pieces of rock as well as large sheets of bedding plane-failing from high elevation. Since the cliffs here are much higher than anywhere else in the study area, location 5 could produce a slide of a much larger volume of rock than the other locations exhibiting two failure types.

## Conclusions

Of the eight sub-regions of study, all except one show an elevated risk for landslides. The two most hazardous regions are the coast along the northeast edge of the city of Ancona and the coast at the base of Monte Conero. The shoreline near Ancona is the most crowded of all the beaches in the region of study. There is a high risk of large blocks falling in this area due to planar and wedge failure created by joint planes. These blocks could seriously injure people on the beach. Until preventative measures to stabilize the area are taken, beachgoers should avoid these cliffs. Monte Conero is the region at risk of the largest volume and highest energy landslide in the area due to the high elevation. The dense concentration of bedding planes oriented for planar failure along with the wedge-failure-forming joints and stylolites make Monte Conero unstable. These factors combined could create a high-volume slide similar to the $14^{th}$-century Portonovo slide. Overall, this entire region is unstable due to orientations of joints, stylolites, and bedding.

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# Figures and Tables


Figure 1 Field area of the coastline between Ancona and Monte Conero.

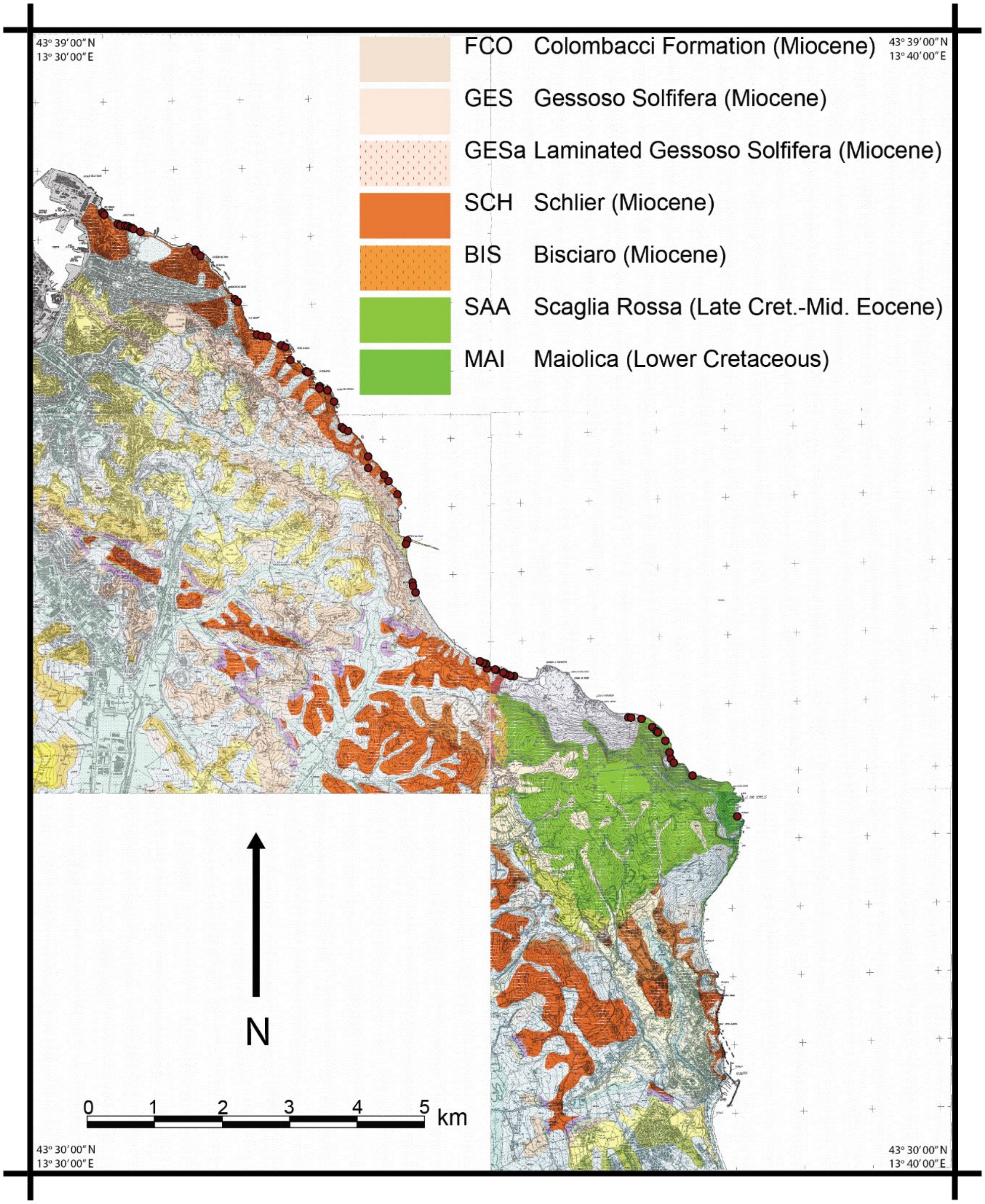



Figure 2 Geologic map of the field area.

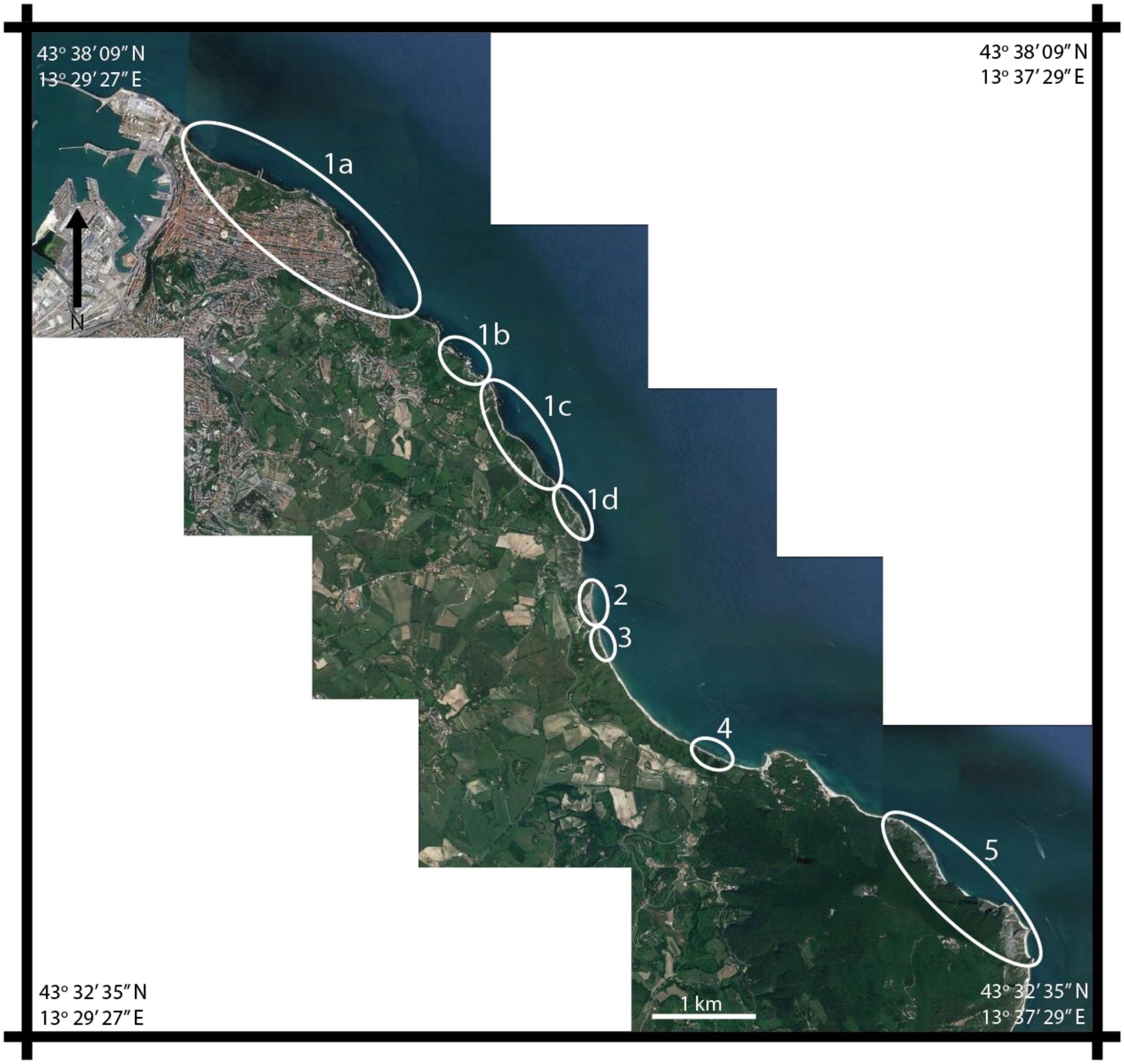



Figure 3 Sub-regions of study. These regions were created based on their lithology and the orientations of the structures.

Figure 4 The Miocene Schlier limestone unit above boat houses carved into the cliffs of the Conero Riviera.

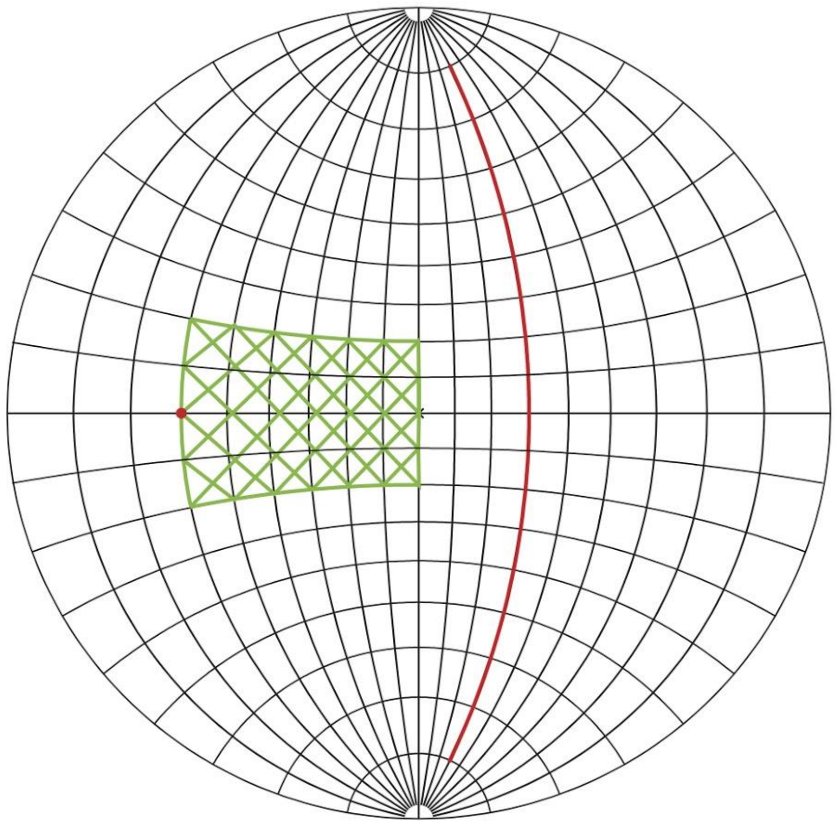


Figure 5 For a cliff slope striking due North and dipping 60 degrees East, the planar failure region (green hatched area) is the area determined by the pole to the plane in question trending within 20 degrees of the pole of the slope in this example (red) and plunging less than or equal to the slope's pole.

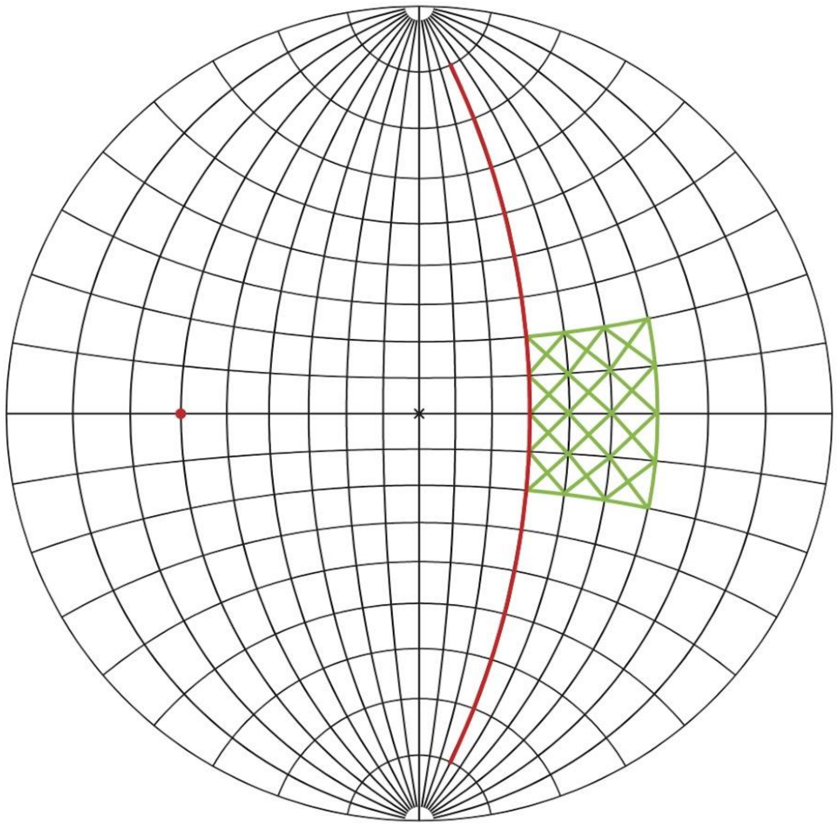


Figure 6 The green region represents the area in which the line of intersection between two planes must lie in order to be susceptible for wedge failure for a cliff face striking North and dipping 60 East. This line must be within 20 degrees of the dip direction of the slope. The dip of this line must be greater than the angle of friction but less that the slope's dip angle.

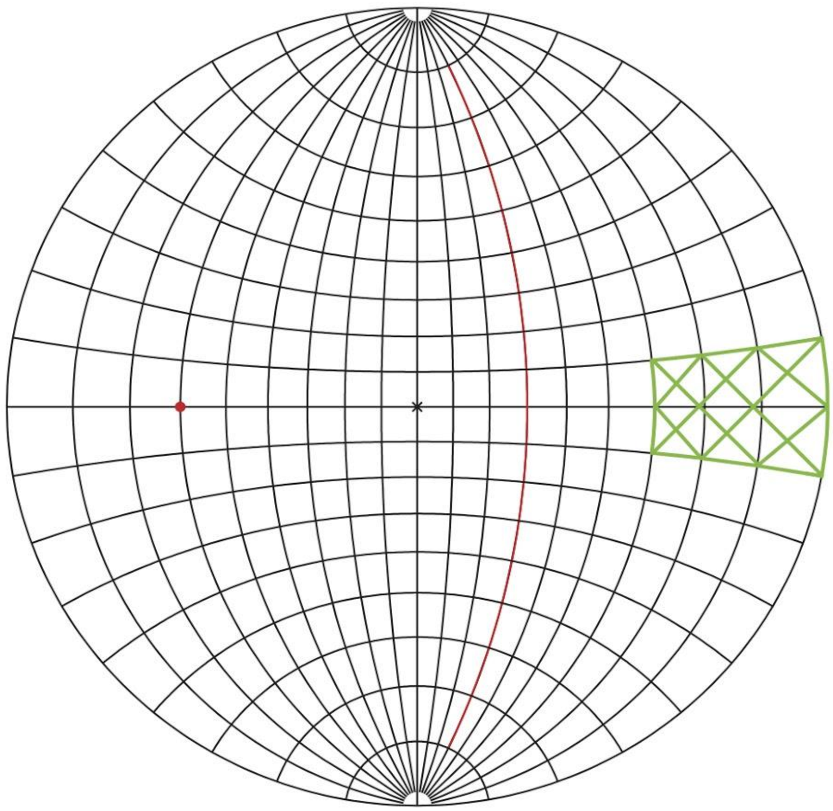


Figure 7 The green area represents the region that the pole to a given plane has to lie within to fulfill the criteria for topple failure for a cliff face striking North and dipping 60 East. The pole must trend within 10 degrees of the dip direction of the slope face.

| Variable | Definition |
| --- | --- |
| $\psi$ | Slip envelope |
| $\alpha_s$ | Dip direction of the slope face |
| $\alpha_p$ | Dip direction of the plane |
| $\theta_s$ | Dip angle of the slope face |
| $\theta_p$ | Dip angle of the plane |
| $\beta_l$ | Trend of line of intersection of two planes |
| $\mu_l$ | Plunge of line of intersection of two planes |

Table 1: Variables for kinematic analysis equations

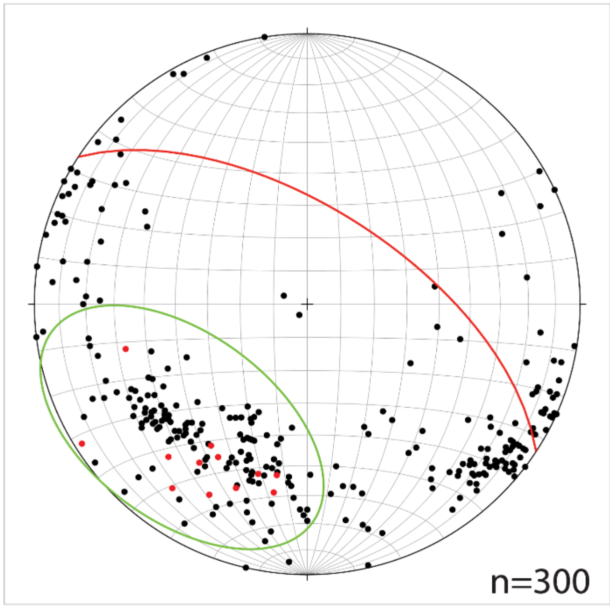
| **Planar Failure** |
| --- |
| • $\alpha_s - 20 \leq \alpha_p \leq \alpha_s + 20$<br>• $\psi \leq \theta_p \leq \theta_s$ |
| **Wedge Failure** |
| • $\alpha_s - 20 \leq \beta_l \leq \alpha_s + 20$<br>• $\psi \leq \mu_l \leq \theta_s$ |
| **Topple Failure** |
| • $\alpha_s - 10 \leq \alpha_p \leq \alpha_s + 10$<br>• $90 - \theta_p + \psi \leq \theta_s$ |

Table 2: Equations of the criteria for different forms of failure.

| Location | Unit(s) | Bedding | Joints (a) | Joints (b) | Joints (c) | Joint density (m) | Slope | Cliff height (m) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1a | Schlier/ Bisciaro | 127/28 | 305/56 | 215/78 | | 0.05-4 | 295/55 | 40-85 |

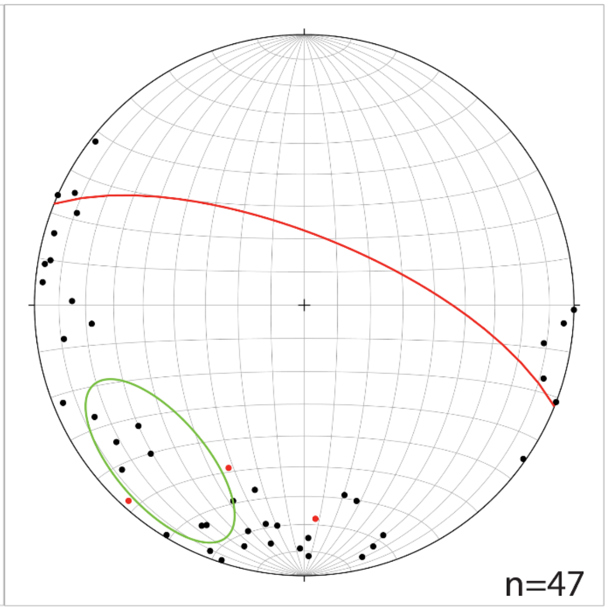
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1b | Schlier/ Bisciaro | 127/28 | 015/85 | 269/69 | 330/76 | | 304/71 | 50-110 |
| 1c | Schlier/ Bisciaro | 127/28 | | | | | 337/61 | 80-170 |
| 1d | Schlier/ Bisciaro | 127/28 | 303/63 | 198/86 | | 0.08-0.3 | 326/54 | 180-210 |
| 2 | Colombacci | 112/40 | 359/78 | 269/68 | | 0.1-0.3 | 340/60 | 150-160 |
| 3 | Gessoso-Solfifera | 108/66 and 285/32 | | | | | 340/60 | 130-150 |
| 4 | Schlier/ Bisciaro | 093/40 | | | | | 265/90 | 90-120 |
| 5 | Scaglia Rossa/ Maiolica | 318/53 | | | | | 313/53 | 360-530 |

Table 3: Mean structural data for structures that formed families



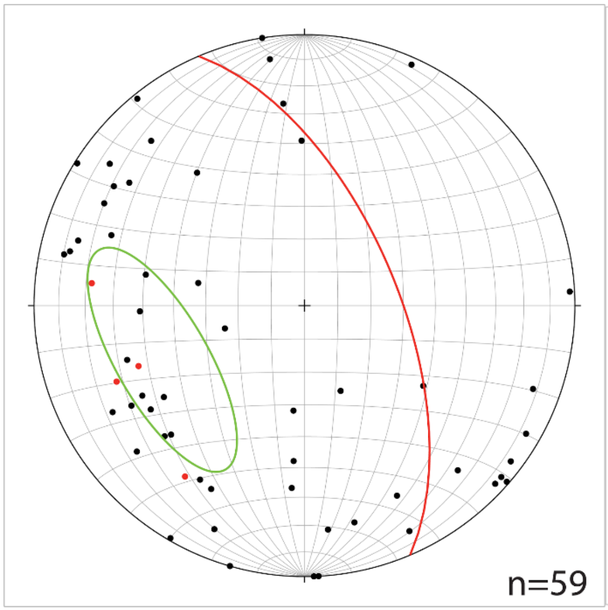

**Location 1a.**

Figure 8a



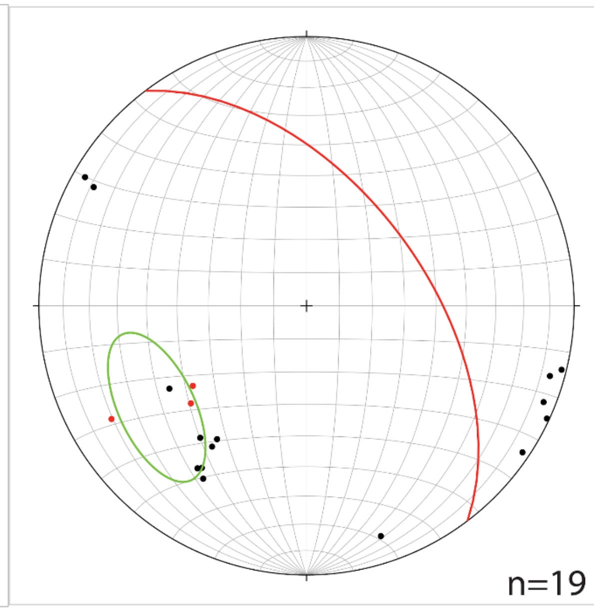

**Location 1b.**

Figure 8b



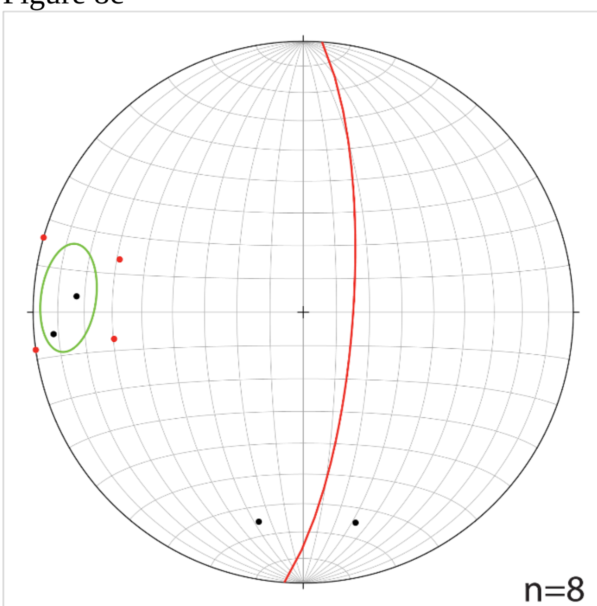

**Location 1c.**

Figure 8c



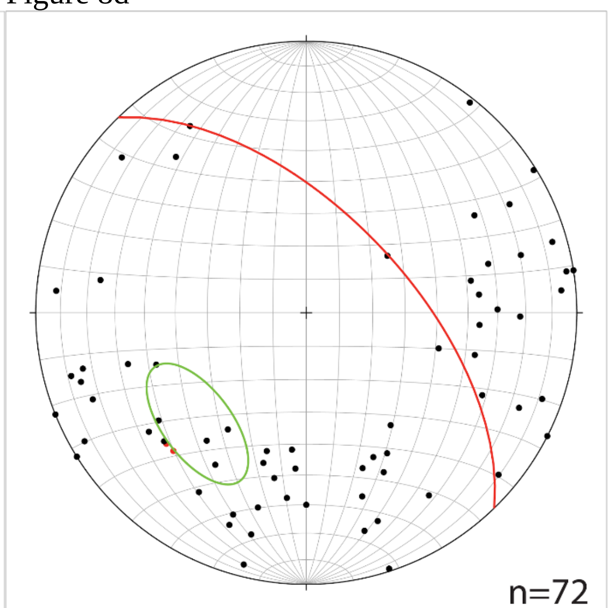

**Location 1d.**

Figure 8d



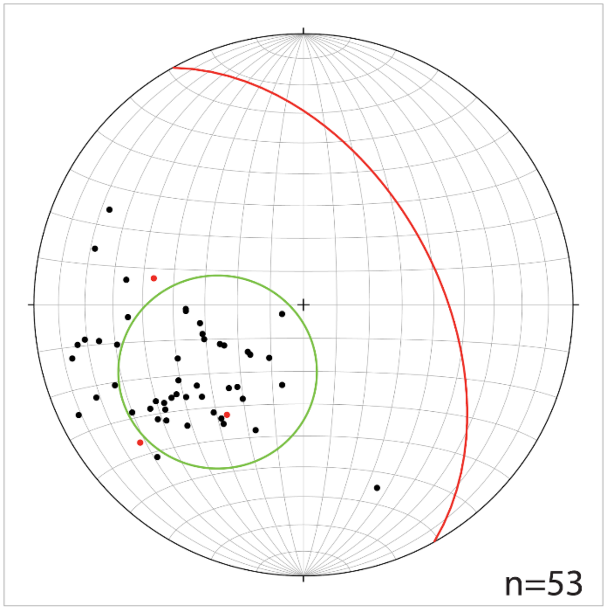

**Location 2.**

Figure 8e




**Location 4.**

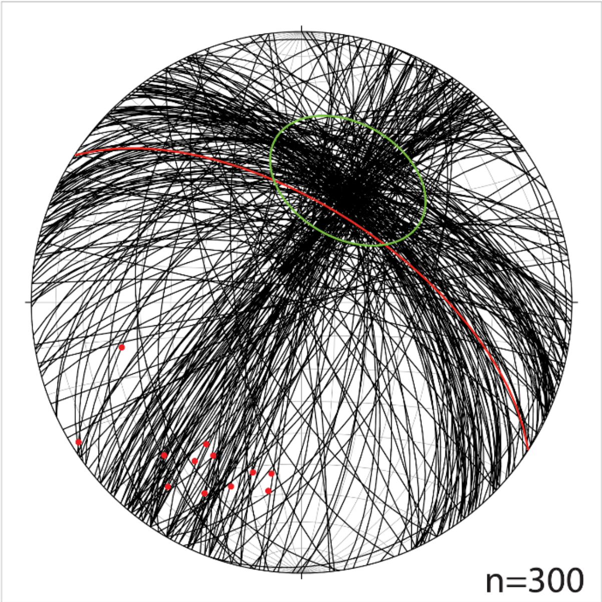
Figure 8f




**Location 5.**

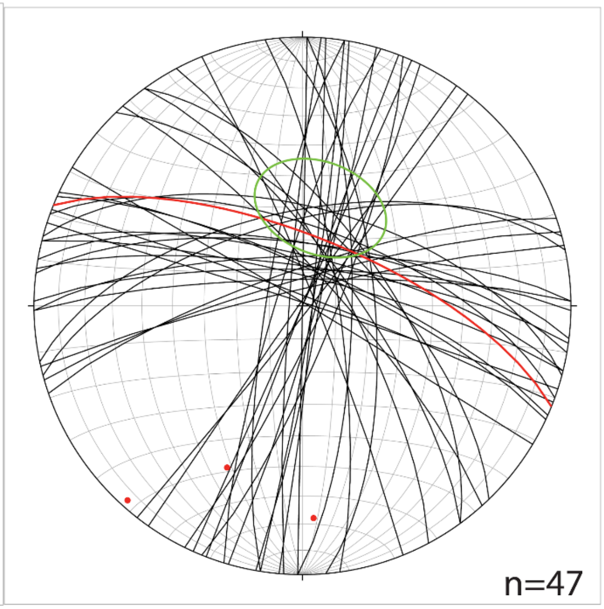
Figure 8g

Figure 8a-8f Planar failure analysis for locations 1a-d, 2, 4, and 5. Poles to structures (black), poles to cliff face (red) and average cliff face (red plane) for each location. Structures oriented for failure are circled in green. The failure planes in Figure 8f are bedding. All other planar failure planes are joints.



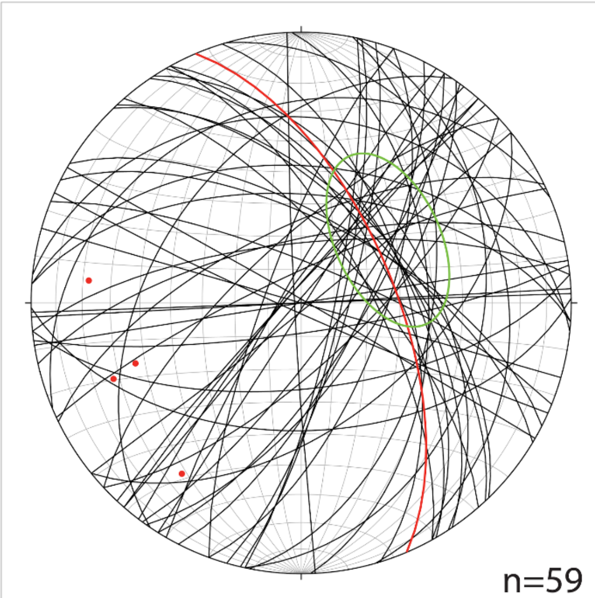

**Location 1a.**

Figure 8h



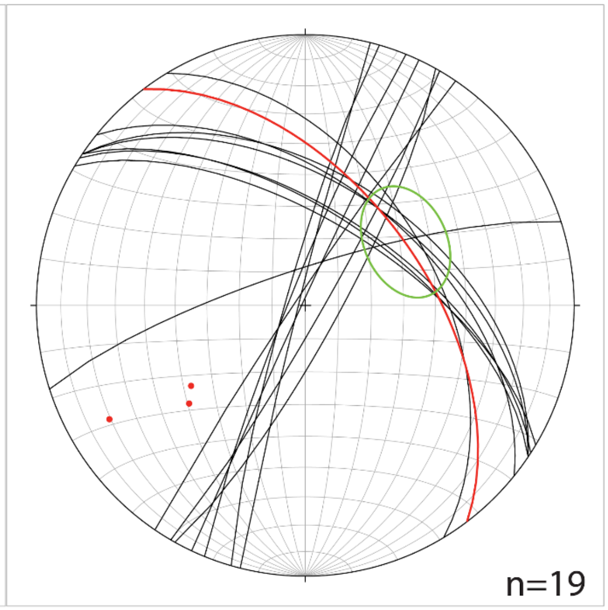

**Location 1b.**

Figure 8i



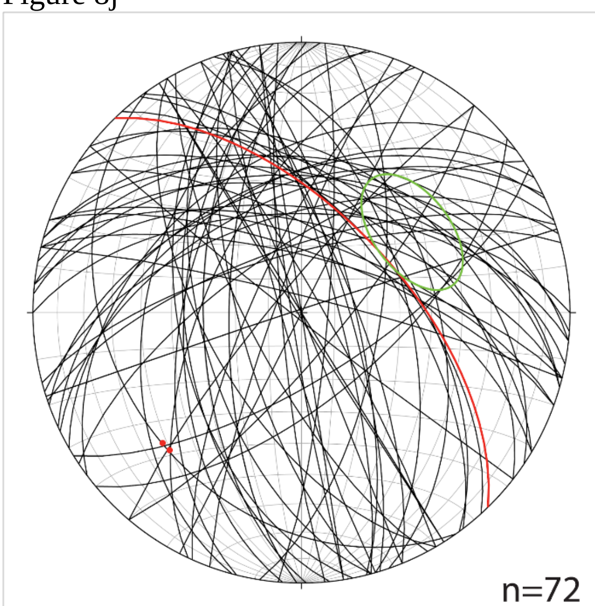

**Location 1c.**

Figure 8j



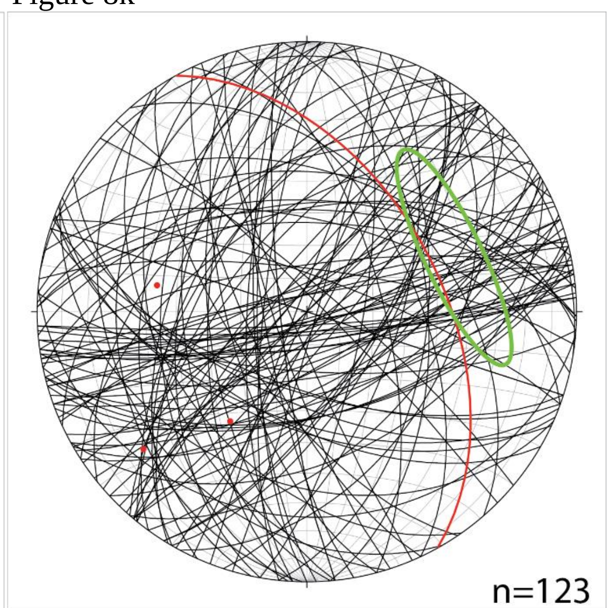

**Location 1d.**

Figure 8k




**Location 4.**

Figure 8l




**Location 5.**

Figure 8m

Figure 8h-8m Wedge failure analysis for locations 1a-d and 4. Planes of structures (black), poles to cliff face (red) and average cliff face (red plane) for each location. Intersections lines of structures oriented for failure are circled in green. All wedge failure planes are joints except for Figure 8m--these are joints and stylolites.

Figure 9 Planar failure along a joint plane of a Schlier limestone block near the Ancona shipyard.

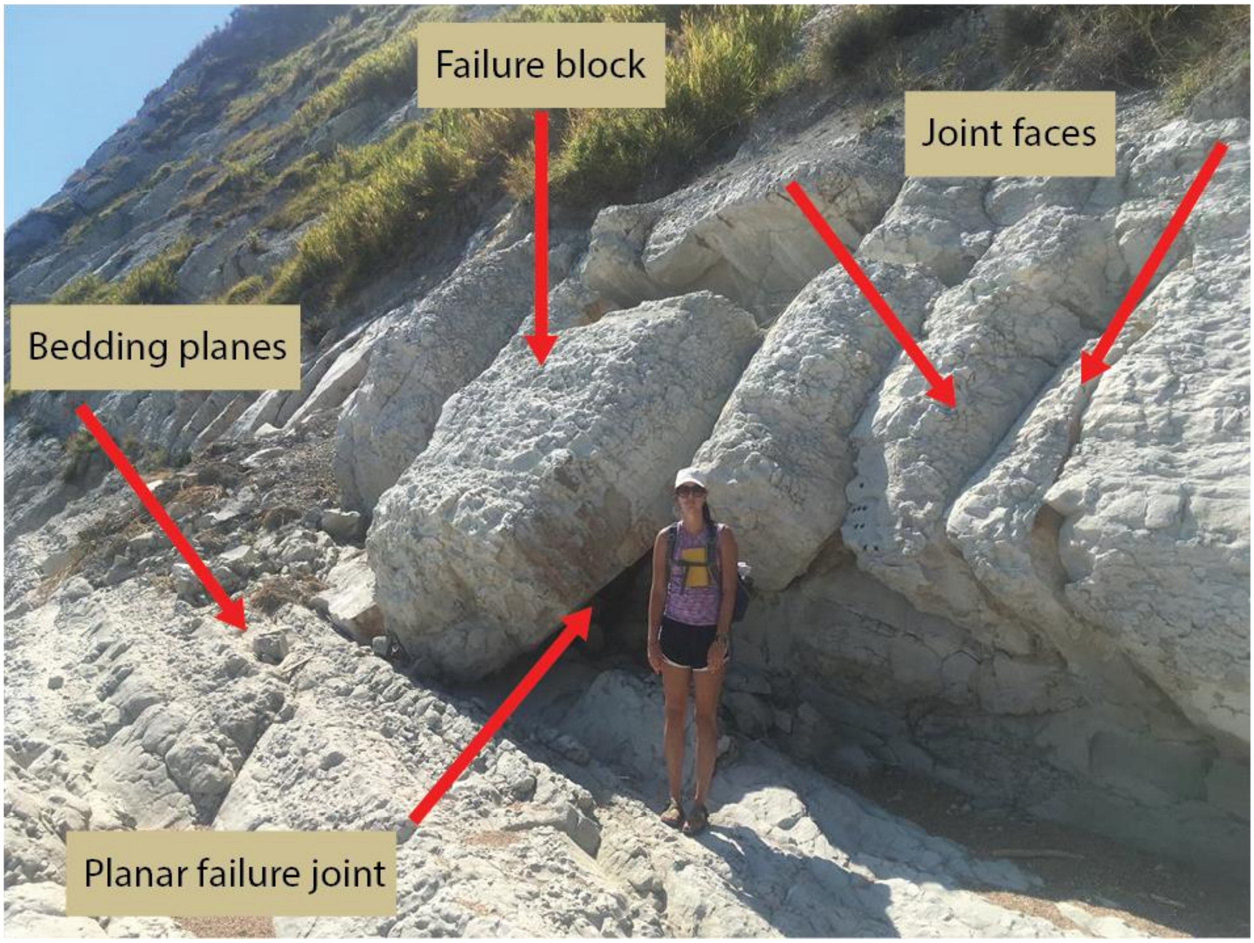


Figure 10 Planar failure along a joint plane of a block of Bisciaro limestone near the Ancona shipyard.

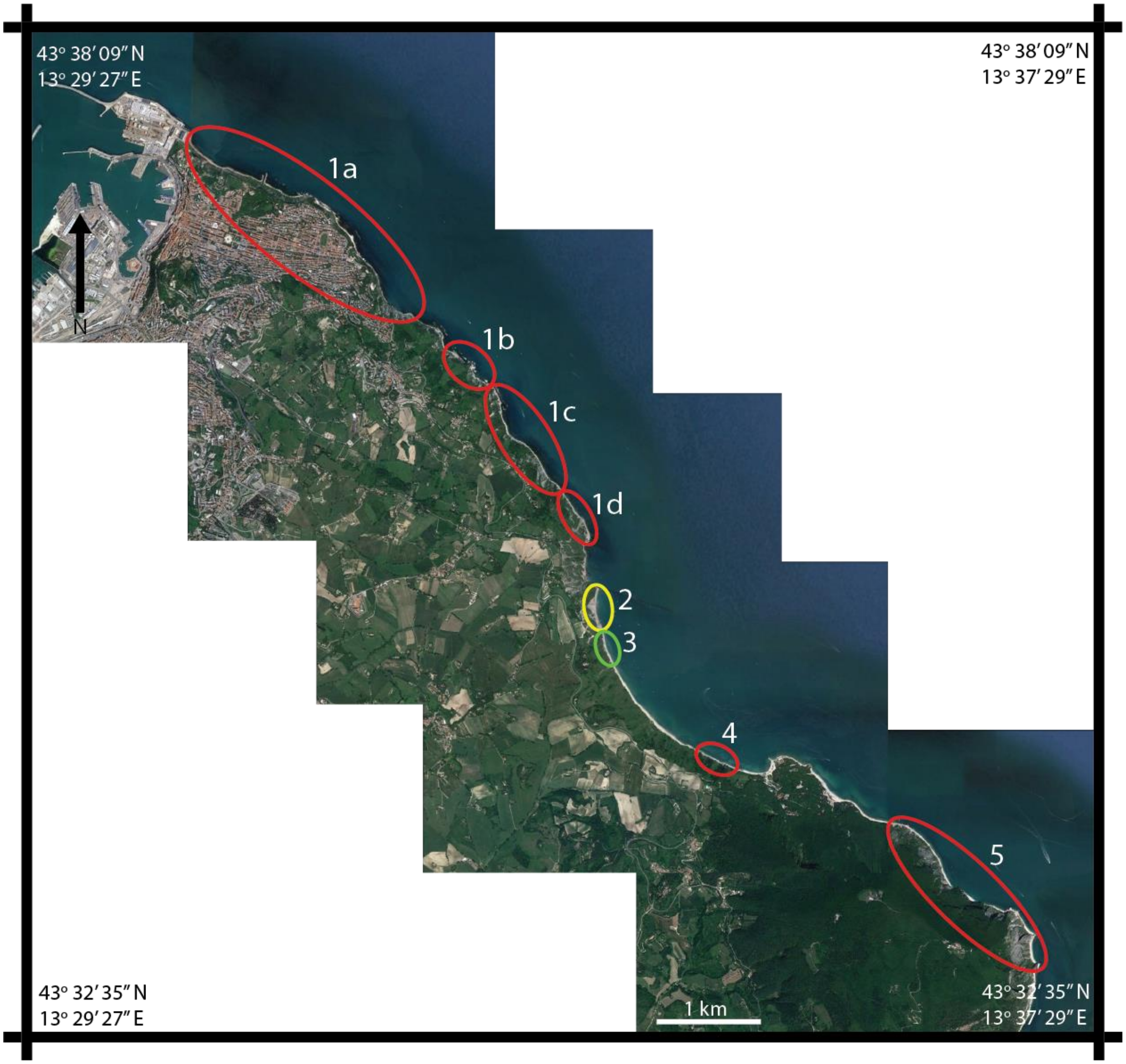



Figure 11 Relative risk map. Red outlines indicate highest risk of kinematic failure induced landslides. Yellow indicates intermediate risk, and green indicates low risk. Areas in red are at risk of wedge and planar failure. The area in yellow is at risk of planar failure. And the area in green has no kinematic risk.

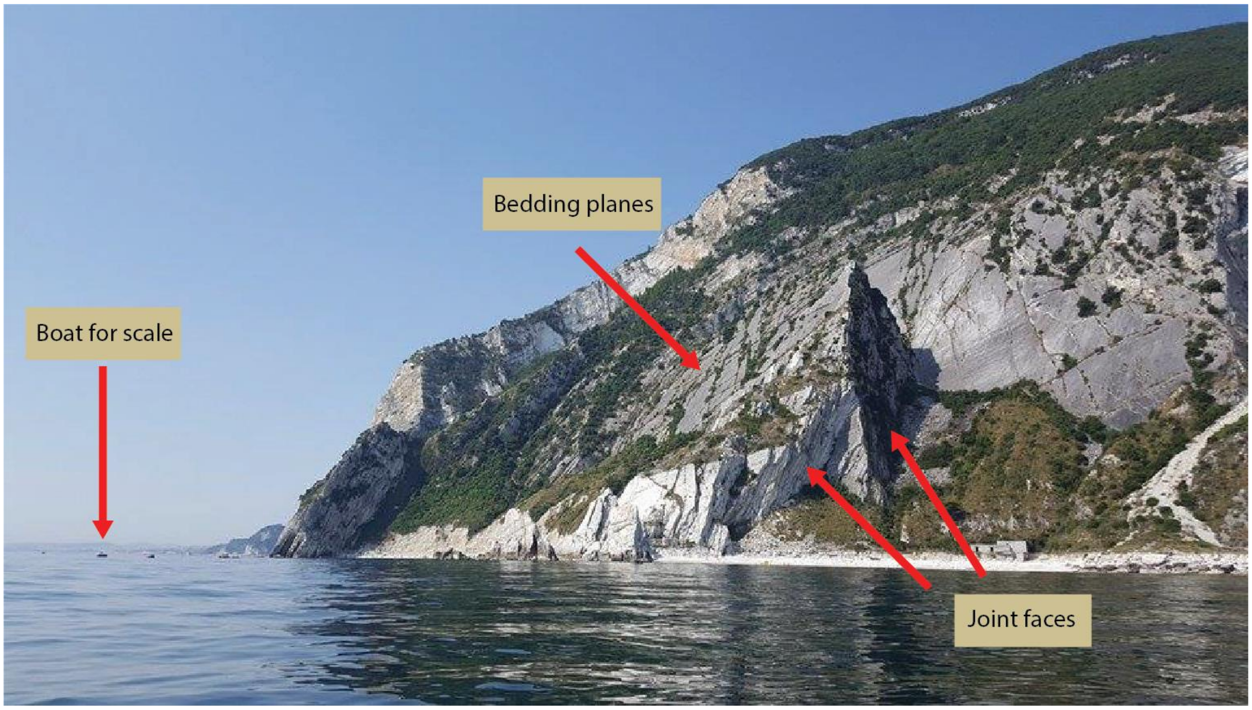


Figure 12 Exposed bedding planes oriented for planar failure, detachment scars, and joints on Monte Conero at the southernmost end of the field area.

# Appendix: Structural Data

| Key | |
|---|---|
| b | bedding |
| j | joints |
| s | slope |
| ps | pressure solution |
| f | fault without sense of motion |
| nf | normal fault |
| tf | thrust fault |
| sf | sinistral fault |
| df | dextral fault |

| Stop | Structure | Strike | Dip | Rake |
|---|---|---|---|---|
| 1 | b | 75 | 43 | |
| | | 80 | 38 | |
| | | 49 | 18 | |
| | | 86 | 40 | |
| | | 95 | 49 | |
| 2 | b | 75 | 62 | |
| | | 70 | 48 | |
| | | 72 | 52 | |
| | j | 195 | 42 | |
| | | 128 | 88 | |
| 3 | b | 62 | 49 | |
| | | 60 | 52 | |
| | j | 181 | 68 | |
| | | 174 | 60 | |
| | | 169 | 52 | |
| | | 184 | 54 | |
| | | 194 | 54 | |
| 4 | b | 266 | 79 | |
| | | 262 | 79 | |
| | | 258 | 75 | |
| | | 256 | 73 | |
| | j | 148 | 87 | |
| | | 5 | 82 | |
| | | 330 | 84 | |

| | | | | |
|---|---|---|---|---|
| | | 164 | 84 | |
| | | 165 | 69 | |
| | | 165 | 71 | |
| 5 | j | 148 | 89 | |
| | | 240 | 50 | |
| | | 250 | 51 | |
| | | 244 | 55 | |
| | | 304 | 43 | |
| | | 171 | 87 | |
| 6 | b | 264 | 74 | |
| | | 244 | 70 | |
| | | 260 | 71 | |
| | | 261 | 71 | |
| 7 | j | 9 | 66 | |
| | | 324 | 57 | |
| | | 338 | 90 | |
| 6 | landslide face | 260 | 90 | |
| | | 270 | 90 | |
| | j | 252 | 89 | |
| | | 328 | 90 | |
| 8 | j | 174 | 54 | |
| | | 284 | 73 | |
| | | 181 | 68 | |
| | | 276 | 42 | |
| | | 276 | 58 | |
| | | 205 | 61 | |
| | | 255 | 72 | |
| | | 274 | 48 | |
| | | 233 | 43 | |
| | b | 94 | 40 | * |
| | | 94 | 72 | * |
| 9 | b | 112 | 40 | |
| | | 111 | 28 | |
| | | 115 | 48 | |
| | | 114 | 35 | |
| | | 102 | 32 | |
| | | 110 | 55 | |
| | | 104 | 50 | |
| | J | 345 | 79 | |

| | | | | |
|---|---|---|---|---|
| | | 286 | 48 | |
| | | 284 | 63 | |
| | | 171 | 90 | |
| | | 200 | 82 | |
| | | 207 | 90 | |
| | | 220 | 82 | |
| | | 338 | 74 | |
| | | 286 | 44 | |
| | | 308 | 50 | |
| | | 40 | 78 | |
| 11 | j | 150 | 62 | |
| | | 245 | 79 | |
| | | 250 | 64 | |
| | b | 145 | 30 | |
| 10 | j | 343 | 76 | |
| | | 284 | 85 | |
| | | 152 | 74 | |
| | | 58 | 70 | |
| | | 204 | 75 | |
| | | 236 | 70 | |
| 12 | b | 110 | 36 | |
| | | 101 | 40 | |
| | | 97 | 25 | |
| | | 113 | 27 | |
| | | 105 | 28 | |
| | j | 323 | 62 | |
| | | 290 | 68 | |
| | | 346 | 74 | |
| | | 301 | 66 | |
| | | 341 | 49 | |
| | | 318 | 60 | |
| | | 175 | 84 | |
| | | 270 | 60 | |
| | | 344 | 58 | |
| | | 281 | 52 | |
| | | 301 | 55 | |
| | | 253 | 60 | |
| | | 251 | 70 | |
| | | 290 | 72 | |

| | | | | |
|---|---|---|---|---|
| 14 | b | 120 | 61 | |
| | | 105 | 80 | |
| | | 111 | 68 | |
| | | 93 | 48 | |
| | | 105 | 70 | |
| | | 109 | 58 | |
| | | 286 | 58 | |
| | | 285 | 61 | |
| | | 285 | 61 | |
| | | 284 | 70 | |
| 15 | TF | 285 | 10 | |
| 16 | j | 321 | 58 | |
| | | 372 | 65 | |
| | | 224 | 72 | |
| | | 228 | 82 | |
| | | 335 | 54 | |
| | | 221 | 80 | |
| | | 335 | 66 | |
| | | 282 | 52 | |
| | | 214 | 79 | |
| | | 222 | 79 | |
| | | 339 | 68 | |
| | | 225 | 78 | |
| | | 282 | 49 | |
| | | 333 | 60 | |
| | | 270 | 65 | |
| | b | 114 | 38 | |
| | | 105 | 35 | |
| | | 123 | 35 | |
| | | 116 | 35 | |
| | | 135 | 32 | |
| 17 | b | 126 | 26 | |
| 18 | b | 135 | 20 | |
| | | 119 | 24 | |
| 19 | b | 115 | 37 | |
| | | 129 | 31 | |
| 20 | j | 24 | 88 | |
| | | 218 | 86 | |
| | | 25 | 86 | |

| | | | | |
|---|---|---|---|---|
| | | 30 | 80 | |
| 21 | s | 328 | 87 | |
| | | 304 | 60 | |
| | b | 112 | 18 | |
| | | 130 | 40 | |
| | | 135 | 33 | |
| | j | 20 | 85 | |
| | | 205 | 89 | |
| | | 306 | 4 | |
| | | 314 | 78 | |
| | | 320 | 60 | |
| | | 260 | 70 | |
| | | 334 | 61 | |
| | | 288 | 58 | |
| | | 29 | 80 | |
| | | 323 | 65 | |
| 22 | b | 120 | 31 | |
| | j | 333 | 81 | |
| | | 314 | 86 | |
| | | 274 | 85 | |
| | | 299 | 82 | |
| | | 256 | 73 | |
| | | 254 | 62 | |
| | | 17 | 68 | |
| | | 321 | 55 | |
| | | 283 | 90 | |
| | s | 280 | 60 | |
| | | 291 | 62 | |
| 23 | s | 126 | 73 | |
| | b | 149 | 24 | |
| | j | 11 | 71 | |
| | | 354 | 87 | |
| | | 233 | 65 | |
| | | 173 | 70 | |
| | | 27 | 85 | |
| | | 257 | 89 | |
| | | 353 | 90 | |
| | | 235 | 82 | |
| 24 | j | 263 | 60 | |

| | | | | |
|---|---|---|---|---|
| | | 349 | 70 | |
| | | 280 | 64 | |
| | | 270 | 69 | |
| | | 291 | 61 | |
| | | 81 | 90 | |
| | | 288 | 55 | |
| | | 39 | 77 | |
| | | 291 | 50 | |
| | | 41 | 82 | |
| | | 287 | 65 | |
| | | 296 | 55 | |
| | | 68 | 88 | |
| | | 255 | 75 | |
| | | 311 | 49 | |
| | | 288 | 58 | |
| | | 60 | 88 | |
| | | 291 | 52 | |
| 25 | s | 132 | 65 | |
| | b | 150 | 22 | |
| | j | 205 | 85 | |
| | | 336 | 75 | |
| | | 286 | 69 | |
| | | 252 | 78 | |
| | | 285 | 58 | |
| | | 271 | 67 | |
| 27 | nf | 128 | 58 | |
| 29 | b | 298 | 47 | |
| 30 | b | 103 | 34 | |
| | j | 4 | 73 | |
| | | 256 | 69 | |
| | | 355 | 82 | |
| | | 282 | 68 | |
| 31 | j | 193 | 48 | |
| | | 155 | 90 | |
| 32 | f | 190 | 40 | |
| 33 | b | 142 | 16 | |
| | j | 8 | 90 | |
| | | 318 | 45 | |
| | | 235 | 68 | |

| | | | | |
|---|---|---|---|---|
| | | 234 | 44 | |
| 34 | s | 297 | 68 | |
| | | 346 | 58 | |
| | | 300 | 55 | |
| | j | 303 | 75 | |
| | | 260 | 51 | |
| | | 1 | 65 | |
| | | 279 | 74 | |
| | | 15 | 89 | |
| | | 284 | 72 | |
| 35 | j | 335 | 47 | |
| | | 197 | 86 | |
| 36 | s | 267 | 68 | |
| | b | 114 | 30 | |
| | j | 316 | 68 | |
| | | 277 | 71 | |
| | | 280 | 71 | |
| | | 251 | 79 | |
| | | 1 | 75 | |
| | | 285 | 60 | |
| 37 | b | 125 | 14 | |
| | j | 22 | 80 | |
| | | 284 | 75 | |
| | | 318 | 80 | |
| | | 295 | 79 | |
| | | 271 | 79 | |
| | | 181 | 90 | |
| | | 257 | 85 | |
| | | 288 | 89 | |
| | | 254 | 82 | |
| | | 26 | 84 | |
| | | 301 | 89 | |
| | | 291 | 87 | |
| | | 201 | 90 | |
| | | 284 | 81 | |
| | | 10 | 85 | |
| | | 269 | 82 | |
| 38 | b | 171 | 18 | |
| | | 141 | 28 | |

| | | | | |
|---|---|---|---|---|
| | j | 189 | 79 | |
| | | 215 | 89 | |
| | | 294 | 78 | |
| | | 269 | 75 | |
| | | 38 | 88 | |
| | | 184 | 86 | |
| | | 355 | 68 | |
| | | 16 | 86 | |
| | | 197 | 82 | |
| | | 290 | 66 | |
| | | 9 | 87 | |
| | | 24 | 90 | |
| | | 255 | 64 | |
| | | 5 | 87 | |
| 39 | s | 312 | 87 | |
| | | 295 | 56 | |
| | j | 324 | 65 | |
| | | 332 | 77 | |
| | | 352 | 79 | |
| | | 338 | 86 | |
| | | 278 | 78 | |
| | | 324 | 75 | |
| | | 258 | 61 | |
| 40 | b | 144 | 12 | |
| | j | 297 | 65 | |
| | | 221 | 89 | |
| | | 12 | 33 | |
| | | 327 | 52 | |
| | | 274 | 48 | |
| 41 | s | 340 | 55 | |
| | b | 149 | 15 | |
| | | 157 | 14 | |
| | | 164 | 22 | |
| | | 132 | 30 | |
| | j | 89 | 51 | |
| | | 300 | 89 | |
| | | 227 | 72 | |
| | | 264 | 72 | |
| | | 316 | 58 | |

| | | | | |
|---|---|---|---|---|
| | | 51 | 88 | |
| | | 326 | 58 | |
| | | 274 | 57 | |
| | | 358 | 51 | |
| | | 35 | 68 | |
| | | 47 | 72 | |
| | | 276 | 32 | |
| | | 257 | 71 | |
| | | 81 | 90 | |
| | | 217 | 85 | |
| | | 317 | 60 | |
| | | 267 | 90 | |
| 42 | s | 6 | 68 | |
| | | 305 | 66 | |
| | b | 154 | 13 | |
| | | 147 | 25 | |
| | j | 16 | 76 | |
| | | 13 | 78 | |
| | | 292 | 78 | |
| | | 12 | 80 | |
| | | 331 | 58 | |
| | | 11 | 50 | |
| | | 301 | 64 | |
| 43 | nf | 219 | 35 | 15E |
| | nf | 229 | 28 | 22E |
| | nf | 58 | 73 | 27E |
| | b | 155 | 33 | |
| | j | 330 | 63 | |
| | | 27 | 72 | |
| | | 286 | 90 | |
| | | 268 | 90 | |
| 44 | df | 310 | 55 | 0 |
| | j | 32 | 89 | |
| | | 114 | 87 | |
| | | 210 | 84 | |
| | | 32 | 72 | |
| | | 82 | 81 | |
| | | 177 | 88 | |
| | | 221 | 86 | |

| | | | | |
|---|---|---|---|---|
| 45 | nf | 189 | 70 | 20N |
| | j | 36 | 78 | |
| | | 51 | 53 | |
| | | 244 | 67 | |
| | | 84 | 64 | |
| 46 | s | 338 | 64 | |
| | b | 134 | 32 | |
| | | 140 | 32 | |
| 47 | s | 315 | 60 | |
| | b | 119 | 18 | |
| | j | 319 | 71 | |
| | | 247 | 28 | |
| | | 20 | 65 | |
| | | 343 | 58 | |
| | | 245 | 81 | |
| 49 | b | 116 | 31 | |
| | | 117 | 32 | |
| | j | 344 | 25 | |
| | | 200 | 79 | |
| | | 223 | 86 | |
| | | 331 | 70 | |
| | | 214 | 44 | |
| | nf | 127 | 74 | 55E |
| | nf | 110 | 59 | 84W |
| | sf | 347 | 31 | 14S |
| 50 | s | 325 | 43 | |
| | b | 137 | 34 | |
| | j | 30 | 85 | |
| | | 303 | 61 | |
| | | 329 | 50 | |
| | | 252 | 79 | |
| | | 205 | 89 | |
| 51 | s | 220 | 47 | |
| | b | 115 | 39 | |
| | | 119 | 31 | |
| | j | 304 | 50 | |
| | | 309 | 53 | |
| | | 304 | 53 | |
| | | 196 | 84 | |

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|---|---|---|---|---|
| | | 214 | 87 | |
| 53 | s | 330 | 73 | |
| | b | 114 | 40 | |
| | j | 194 | 88 | |
| | | 301 | 64 | |
| | | 202 | 85 | |
| | | 29 | 80 | |
| | | 304 | 62 | |
| 61 | s | 10 | 47 | |
| | b | 15 | 69 | |
| | | 26 | 69 | |
| | j | 274 | 47 | |
| | | 271 | 59 | |
| | | 290 | 47 | |
| | | 272 | 56 | |
| | | 265 | 57 | |
| north | b | 347 | 77 | |
| | | 356 | 55 | |
| | | 350 | 66 | |
| | | 351 | 71 | |
| 62 | b | 350 | 32 | |
| | | 350 | 74 | |
| | | 344 | 32 | |
| | | 341 | 32 | |
| | | 358 | 36 | |
| | | 357 | 36 | |
| | | 270 | 78 | |
| | j | 163 | 42 | |
| | | 40 | 80 | |
| | | 25 | 90 | |
| | | 87 | 86 | |
| | tf | 158 | 45 | |
| | f | 86 | 90 | 21E |
| | f | 217 | 70 | 20E |
| 63 | tf | 54 | 64 | |
| | b | 337 | 42 | |
| | | 320 | 22 | |
| | | 303 | 19 | |
| | | 303 | 34 | |

| | | | | |
|---|---|---|---|---|
| | | 335 | 28 | |
| | ps | 120 | 57 | |
| | | 87 | 84 | |
| | | 162 | 80 | |
| | | 180 | 75 | |
| | | 178 | 74 | |
| | | 260 | 85 | |
| 64 | b | 323 | 41 | |
| | | 322 | 46 | |
| | ps | 81 | 70 | |
| | | 190 | 51 | |
| | | 277 | 77 | |
| | | 146 | 67 | |
| | | 236 | 85 | |
| | | 184 | 45 | |
| | | 74 | 86 | |
| 65 | b | 314 | 67 | |
| | ps | 247 | 85 | |
| | | 224 | 90 | |
| | | 222 | 85 | |
| | | 210 | 55 | |
| | | 16 | 87 | |
| | | 78 | 58 | |
| | | 69 | 63 | |
| | | 157 | 85 | |
| | | 63 | 73 | |
| | | 345 | 67 | |
| | | 220 | 85 | |
| | | 231 | 48 | |
| | | 61 | 45 | |
| 66 | b | 314 | 52 | |
| | | 309 | 32 | |
| | | 306 | 43 | |
| | j | 204 | 49 | |
| | | 57 | 66 | |
| | | 175 | 52 | |
| | | 60 | 61 | |
| | | 256 | 85 | |
| | | 201 | 87 | |

| | | | | |
|---|---|---|---|---|
| | | 59 | 74 | |
| | | 229 | 81 | |
| | ps | 113 | 55 | |
| | | 108 | 90 | |
| | | 28 | 45 | |
| | | 111 | 57 | |
| | | 279 | 6 | |
| | | 115 | 63 | |
| | | 108 | 90 | |
| | | 271 | 63 | |
| | | 6 | 53 | |
| | | 355 | 53 | |
| 67 | b | 333 | 27 | |
| | | 312 | 34 | |
| | | 317 | 22 | |
| | | 323 | 54 | |
| | | 326 | 58 | |
| | j | 174 | 82 | |
| | | 183 | 72 | |
| | | 110 | 67 | |
| | | 174 | 82 | |
| | ps | 52 | 86 | |
| | | 74 | 58 | |
| | | 60 | 82 | |
| | | 47 | 90 | |
| | | 70 | 87 | |
| | | 18 | 62 | |
| | s | 110 | 80 | |
| 68 | b | 310 | 43 | |
| | | 328 | 64 | |
| | | 320 | 56 | |
| | | 322 | 58 | |
| | | 325 | 53 | |
| | j | 114 | 37 | |
| | | 80 | 87 | |
| | | 30 | 66 | |
| | | 86 | 83 | |
| | | 155 | 72 | |
| | | 258 | 59 | |

| | | | | |
|---|---|---|---|---|
| | | 170 | 77 | |
| | ps | 74 | 88 | |
| | | 174 | 60 | |
| | | 76 | 65 | |
| | | 76 | 58 | |
| | | 192 | 39 | |
| | | 262 | 76 | |
| | | 245 | 45 | |
| | | 47 | 65 | |
| | | 186 | 77 | |
| | | 315 | 86 | |
| | | 70 | 75 | |
| | | 84 | 84 | |
| | | 290 | 79 | |
| 69 | b | 325 | 48 | |
| | | 318 | 42 | |
| | | 327 | 55 | |
| | | 329 | 45 | |
| | | 325 | 50 | |
| | j | 150 | 28 | |
| | | 319 | 47 | |
| | | 84 | 79 | |
| | | 10 | 73 | |
| | | 108 | 66 | |
| | | 165 | 66 | |
| | | 70 | 85 | |
| | | 181 | 30 | |
| | | 219 | 81 | |
| | | 237 | 60 | |
| | ps | 41 | 50 | |
| | | 211 | 59 | |
| | | 36 | 69 | |
| | | 32 | 69 | |
| | | 32 | 68 | |
| | | 220 | 77 | |
| | | 335 | 57 | |
| | | 145 | 45 | |
| | | 72 | 77 | |
| | | 216 | 58 | |

| | | | | |
|---|---|---|---|---|
| | | 219 | 66 | |
| | | 95 | 25 | |
| | | 221 | 69 | |
| | | 79 | 87 | |
| | | 81 | 81 | |
| | | 82 | 81 | |
| | | 255 | 83 | |
| | | 183 | 60 | |
| | s | 305 | 41 | |
| 70 | FA | 54 | 35 | 50W |
| | | 45 | 43 | 45W |
| | | 70 | 27 | 61W |
| | | 70 | 30 | 70W |
| | | 102 | 39 | 88W |
| | | 101 | 40 | 84W |
| | FB | 292 | 87 | |
| | | 292 | 90 | |
| | FC | 100 | 86 | 29W |
| | JA | 246 | 82 | |
| | | 40 | 84 | |
| | BA | 291 | 41 | |
| | | 304 | 44 | |
| | JB | 61 | 68 | |
| | | 29 | 86 | |
| | BB | 285 | 35 | |
| | b | 248 | 62 | |
| | | 348 | 60 | |
| 71 | b | 337 | 65 | |
| 72 | b | 334 | 82 | |
| | | 336 | 73 | |
| | | 337 | 7 | |
| | | 350 | 66 | |
| | | 8 | 56 | |
| | s | 320 | 68 | |
| | j | 82 | 79 | |
| | | 310 | 82 | |
| | | 283 | 62 | |
| | | 94 | 72 | |
| 73 | J | 216 | 81 | |

| | | | | |
|---|---|---|---|---|
| | | 217 | 90 | |
| | | 205 | 84 | |
| | | 205 | 88 | |
| | | 210 | 84 | |
| | | 210 | 84 | |
| 74 | J | 193 | 82 | |
| | | 218 | 85 | |
| | | 62 | 86 | |
| | | 224 | 74 | |
| | | 210 | 77 | |
| | | 214 | 80 | |
| | | 302 | 60 | |
| | | 294 | 74 | |
| | | 209 | 84 | |
| | | 214 | 82 | |
| | | 219 | 87 | |
| | | 215 | 81 | |
| | | 214 | 83 | |
| | | 214 | 85 | |
| | | 294 | 50 | |
| | | 276 | 56 | |
| | | 214 | 83 | |
| | | 200 | 84 | |
| | | 303 | 58 | |
| | | 202 | 78 | |
| | | 201 | 86 | |
| | | 210 | 86 | |
| | | 327 | 65 | |
| | | 187 | 75 | |
| | | 214 | 86 | |
| | | 310 | 51 | |
| | | 220 | 89 | |
| | | 313 | 72 | |
| | | 204 | 89 | |
| | | 274 | 61 | |
| | | 200 | 79 | |
| | | 160 | 65 | |
| | | 195 | 72 | |
| 75 | b | 120 | 26 | |

| | | | | |
|---|---|---|---|---|
| | | 125 | 20 | |
| | s | 280 | 54 | |
| | j | 204 | 85 | |
| | | 212 | 68 | |
| | | 222 | 77 | |
| | | 220 | 84 | |
| | | 216 | 86 | |
| | | 216 | 79 | |
| | | 325 | 55 | |
| | | 219 | 74 | |
| | | 220 | 79 | |
| | | 214 | 74 | |
| | | 229 | 73 | |
| | | 335 | 71 | |
| | | 227 | 80 | |
| | | 295 | 46 | |
| | | 217 | 80 | |
| | | 314 | 54 | |
| | | 220 | 86 | |
| | | 313 | 56 | |
| | | 220 | 72 | |
| | | 315 | 61 | |
| | | 221 | 76 | |
| | | 315 | 52 | |
| | | 221 | 80 | |
| | | 315 | 60 | |
| | | 236 | 71 | |
| 76 | j | 220 | 80 | |
| | | 280 | 78 | |
| | | 320 | 61 | |
| | | 224 | 80 | |
| | | 292 | 45 | |
| | | 219 | 83 | |
| | | 324 | 60 | |
| | | 224 | 80 | |
| | | 276 | 54 | |
| | | 219 | 81 | |
| | | 275 | 57 | |
| | | 220 | 80 | |

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|---|---|---|---|---|
| | | 220 | 80 | |
| | | 291 | 45 | |
| | | 221 | 81 | |
| | | 314 | 58 | |
| | | 293 | 45 | |
| | | 225 | 73 | |
| | | 322 | 61 | |
| | | 284 | 55 | |
| | | 256 | 59 | |
| | | 228 | 72 | |
| | | 330 | 51 | |
| | | 228 | 78 | |
| | | 225 | 78 | |
| | | 230 | 70 | |
| | | 226 | 77 | |
| | | 320 | 56 | |
| | | 224 | 79 | |
| | | 329 | 63 | |
| | | 226 | 76 | |
| | | 269 | 53 | |
| | | 281 | 42 | |
| | b | 115 | 32 | |
| | | 110 | 31 | |
| | | 110 | 32 | |
| 77 | b | 115 | 40 | |
| | | 127 | 38 | |
| | j | 150 | 88 | |
| | | 189 | 89 | |
| | | 280 | 53 | |
| | | 157 | 82 | |
| | | 360 | 71 | |
| | | 330 | 57 | |
| | | 295 | 46 | |
| | | 172 | 39 | |
| | | 27 | 90 | |
| | | 310 | 53 | |
| | | 19 | 83 | |
| | | 343 | 50 | |
| | | 150 | 71 | |

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|---|---|---|---|---|
| 78 | b | 131 | 26 | |
| | | 129 | 37 | |
| | j | 20 | 87 | |
| | | 300 | 36 | |
| | | 232 | 80 | |
| | | 327 | 60 | |
| | | 30 | 87 | |
| | | 296 | 53 | |
| | | 204 | 90 | |
| | | 323 | 87 | |
| | | 291 | 68 | |
| | | 315 | 53 | |
| | | 287 | 58 | |
| | | 290 | 55 | |
| | | 26 | 55 | |
| | | 315 | 56 | |
| | | 296 | 57 | |
| | | 8 | 90 | |
| | | 290 | 51 | |
| | | 351 | 70 | |
| | | 325 | 59 | |
| | | 303 | 57 | |
| | | 316 | 57 | |
| | | 296 | 39 | |
| | | 300 | 40 | |
| | | 321 | 57 | |
| | | 245 | 44 | |
| | | 235 | 40 | |
| | | 322 | 60 | |
| | | 210 | 36 | |
| | | 319 | 56 | |
| | | 324 | 64 | |
| | | 30 | 58 | |
| | | 284 | 52 | |
| | | 305 | 53 | |
| | | 346 | 68 | |
| | | 310 | 56 | |
| | | 200 | 87 | |
| | | 288 | 56 | |

| | | | | |
|---|---|---|---|---|
| | | 322 | 56 | |
| | | 314 | 51 | |
| | | 34 | 69 | |
| | | 236 | 56 | |
| 79 | j | 334 | 53 | |
| | | 323 | 55 | |
| | | 233 | 56 | |
| | | 310 | 56 | |
| | | 214 | 70 | |
| | | 325 | 58 | |
| | | 2 | 70 | |
| | | 295 | 38 | |
| | | 291 | 52 | |
| | | 287 | 42 | |
| | | 201 | 79 | |
| | | 302 | 41 | |
| | | 277 | 38 | |
| | | 313 | 55 | |
| | | 208 | 89 | |
| | | 294 | 36 | |
| | | 329 | 55 | |
| | | 309 | 41 | |
| | | 25 | 72 | |
| | | 280 | 50 | |
| | | 297 | 45 | |
| | | 30 | 90 | |
| 80 | b | 116 | 33 | |
| | | 119 | 31 | |
| | s | 304 | 53 | |
| | j | 324 | 62 | |
| | | 193 | 85 | |
| | | 6 | 74 | |
| | | 322 | 51 | |
| | | 300 | 40 | |
| | | 336 | 40 | |
| | | 10 | 80 | |
| | | 294 | 45 | |
| | | 18 | 87 | |
| | | 216 | 62 | |

| | | | | |
|---|---|---|---|---|
| | | 308 | 57 | |
| | | 282 | 44 | |
| | | 226 | 71 | |
| | | 294 | 71 | |
| | | 304 | 42 | |
| | | 5 | 83 | |
| 81 | b | 119 | 29 | |
| | s | 286 | 55 | |
| | j | 295 | 40 | |
| | | 45 | 86 | |
| | | 259 | 58 | |
| | | 294 | 54 | |
| 82 | b | 116 | 33 | |
| | j | 326 | 61 | |
| | | 38 | 87 | |
| | | 332 | 63 | |
| | | 303 | 63 | |
| | | 32 | 72 | |
| | | 330 | 60 | |
| | | 228 | 53 | |