KEY

11e

Dryland Inquiry

Activity 14.1

Name: _____ Course/Section: _____ Date: _____

A When most people think of dry lands and deserts, they imagine hot sandy landscapes. Most of the southwestern United States is desert, including the Sonoran Desert of southern California and Arizona. However, rocky landscapes are typical of most of the Sonoran Desert. Sandy areas like the Algodones Dune Field in **Fig. 14.3** are present but limited. This is the location where *Star Wars* producers filmed desert scenes of the film's planet Tatooine.

1. Notice the sand dunes of the Algodones Dune Field in **Fig. 14.3**. Why do you think there are so few plants growing on the dunes?

* Sand is in motion daily * Very little rainfall
* No top soil
* water drains too rapidly

2. Winds in the Algodones Dune Field can reach velocities up to 60 mph. This can create hazardous conditions and the need for maintenance on the canal and Interstate Highway 8. What would be the hazard and what maintenance would be needed periodically on the canal and Interstate Highway 8 as a result of the hazard?

Blowing sand fills canals, covers roadways, damages equipment, reduces visibility for driving.

3. This region is managed by the U.S. Bureau of Land Management as the Imperial Sand Dunes Recreation Area. Portions of the dunes are available for operating off-road vehicles. What effect do you think the operation of off-road vehicles here would have on plant growth and the hazards you described above?

Off-road vehicles add to the factors stopping plant growth.

B Death Valley is along the border between the Mojave Desert and the Great Basin Desert. Analyze the images of the Death Valley region in **Figs. 14.8–14.10**.

1. Steep mountainous slopes occur on both the east and west sides of Death Valley. There is almost no soil or vegetation on the slopes. Describe what you think conditions would be like in the bedrock canyons on these mountain slopes when a heavy rain falls on them.

when a heavy rain falls little of it soaks into the rocky slopes. Most of it runs off into the steep canyons potentially causing flash floods.

2. Notice the alluvial fans and bajadas that form at the base of the bedrock canyons along the mountain fronts in **Figs. 14.9** and **14.10**. Explain how you think these landforms were formed.

streams that originate in the mountains flow quickly down the steep canyons. when they exit the mountain fronts they slow and drop their sediment, forming the fans.

3. Notice that there is little, if any, standing water in Death Valley on a typical day, even though you can see evidence that water sometimes flows into the valley from the mountains. Death Valley is a closed basin, meaning that water has no way to drain from it. It is also the hottest and driest place in North America. When there is water on the floor of the valley, it is alkaline to salty and not potable (drinkable). How do you think the water gets so alkaline and salty?

Runoff water that enters the valley is rich in ions from chemical weathering of rock. As it evaporates the chemicals become concentrated causing high salinity and precipitation of evaporites

4. Suppose you could walk down to the white patches on the floor of Death Valley in **Fig. 14.9** and examine them. Predict what materials and conditions you would find there.

Evaporite minerals such as aragonite, gypsum, halite, and many others.

like gypsum and halite.

5. Residents of Furnace Creek have grassy lawns, trees, and potable water to drink. Why do you think their water is potable? Rain water from the mountains that has percolated into the alluvial fan and later appears in a spring at Furnace Creek... before making its way to the valley floor.

C Open Google Earth. Type coordinates 33.69°N, 116.25°W into the search box and press Search to go to the location. View the area between the Salton Sea and Palm Springs from an elevation of around 70 km.

1. This area stands out amid the desert mountains to the northeast and southwest because of the irrigated, cultivated land between Palm Springs and the Salton Sea. Where do you think the water that is used to make this valley green comes from? this area is arid, so either from groundwater or imported by pipes and canals.

2. The northeastern edge of the valley is bounded by the southern San Andreas Fault Zone (e.g., 33.767°N, 116.220°W through 33.838°N, 116.310°W), and the southwestern edge of the valley is roughly parallel to the San Andreas. The San Andreas fault zone is primarily a zone of right-lateral displacement along strike-slip faults, but there are other faults within this zone. What kind(s) of faults are probably involved in the continuing development of this fault-bounded valley? *Hint:* Refer to **Fig. 14.7**. this valley is an extension of rift along the Gulf of California, so they are probably normal or normal-oblique faults.

3. Now use the Google Earth search box to navigate to the triangular community of Rancho Mirage (33.738°N, 116.417°W), viewing it from an altitude of around 3 km. Using your mouse, hover over the icons at the top of the Google Earth screen to find and select the "Show historical imagery" feature. Use the slider to go back in time and view how this desert valley has changed, and describe some of the changes you see in the historical imagery.
Rancho Mirage imagery goes back to 1996, before the golf course was built... it shows up by 2002. Historical imagery shows the entire area growing dramatically over the last 40 years.

4. In July of 1979, a violent storm developed here, and nearly 6 in. of rain fell on the San Jacinto Mountains, uphill and to the southwest of Rancho Mirage. At that time, flood control at Rancho Mirage included a system of earthen channels and concrete walls that were overwhelmed by a flash flood. Many homes were damaged, and two lives were lost in the event. Analyze recent images of Rancho Mirage and describe any evidence of flood control measures.
there are now flood control channels on both sides of Rancho Mirage to hopefully divert mountain runoff around the houses.

5. Would you feel safe living at Rancho Mirage? Explain.
No.

D **REFLECT & DISCUSS** The United Nations Convention to Combat Desertification (UNCCD; http://www.unccd.int/en/) points out that many people live in dry lands and that more than half of the world's productive land is dry land. Make a list of hazards that might affect people living a desert community or on a farm or ranch in a dry land along with measures that can be taken to manage the risks associated with those hazards.
* lack of water
* lack of rainfall
* flash floods near stream channels
* shifting sand with winds

Sand Seas of Nebraska and the Arabian Peninsula

Activity 14.2

Name: _____ Course/Section: _____ Date: _____

A Analyze Fig. A14.2.1, which shows part of the Rub' al Khali of the Arabian Desert, centered at 21.794°N, 54.802°E. The Rub' al Khali is reportedly the largest contiguous sand desert or erg in the world. The sand is mostly quartz with a reddish hematite coating transported south by strong winds from Jordan, Syria, and Iraq. These winds, called *shamals*, can reach speeds of nearly 50 mph that last for days. The dunes move across a flat surface formed by clay beds that were deposited in ancient lakes. White patches between the dunes are mostly gypsum. This NASA image was created by Robert Simmon from data collected by the Enhanced Thematic Mapper on Landsat 7 on August 26, 2001, provided by the USGS.

Figure A14.2.1

1. What kind(s) of dunes are visible in this image? Refer to **Fig. 14.2**.
Barchans and barchanoid ridges, formed by constant wind and limited sand.

2. What is the predominant wind direction here, and how can you tell?
From the northwest. the barchan horns point downwind.

B Analyze the USGS orthoimage of part of Nebraska's semiarid Sand Hills region in Fig. A14.2.2 (centered at 42.148°N, 102.321°W) on the next page. Rainwater quickly drains through the porous sand, so the hilltops are dry and support only sparse grass. There is a shallow water table, so there are lakes, marshes, and moist fields between the hills.

1. Several ponds are evident in **Fig. A14.2.2A**, and their upper surfaces coincide with the local water table. Referring to the topographic map in **Fig. A14.2.2B**, what is the elevation of the water table in this area?
approx. 3900ft.

2. The top of one of the dunes is marked with a star. Is the slope on the northwest side of that dune more or less steep than the slope on the southeast side of the dune?
the northwest side is steeper.

3. Which side of the dune marked with a star seems to have a crescent or concave shape?
the southeast side.

4. Compare the shape of the dune marked with a star with dunes shown in **Fig. 14.2**, and interpret the type of dune it is.
Barchan

5. Based on your answers to the previous three questions, interpret the direction the wind blew while these dunes were forming. The wind blew from NW to SE. Explain your reasoning.
Horn direction

6. Some of the sand hills in **Fig. A14.2.2** are mostly isolated from the rest like the one marked with a star. Other dunes line up to form a linear or sinuous ridge. Referring to **Fig. 14.2**, what do we call a ridge of these kinds of dunes?
Barchanoid ridge

7. Use a yellow pencil to color the more isolated dunes, and use a blue pencil to color the ridges of dunes.

8. List some of the ways that the Sand Hills dunes are similar to the sand dunes of the Rub' al Khali.
See next page
they are similar in form and in direction

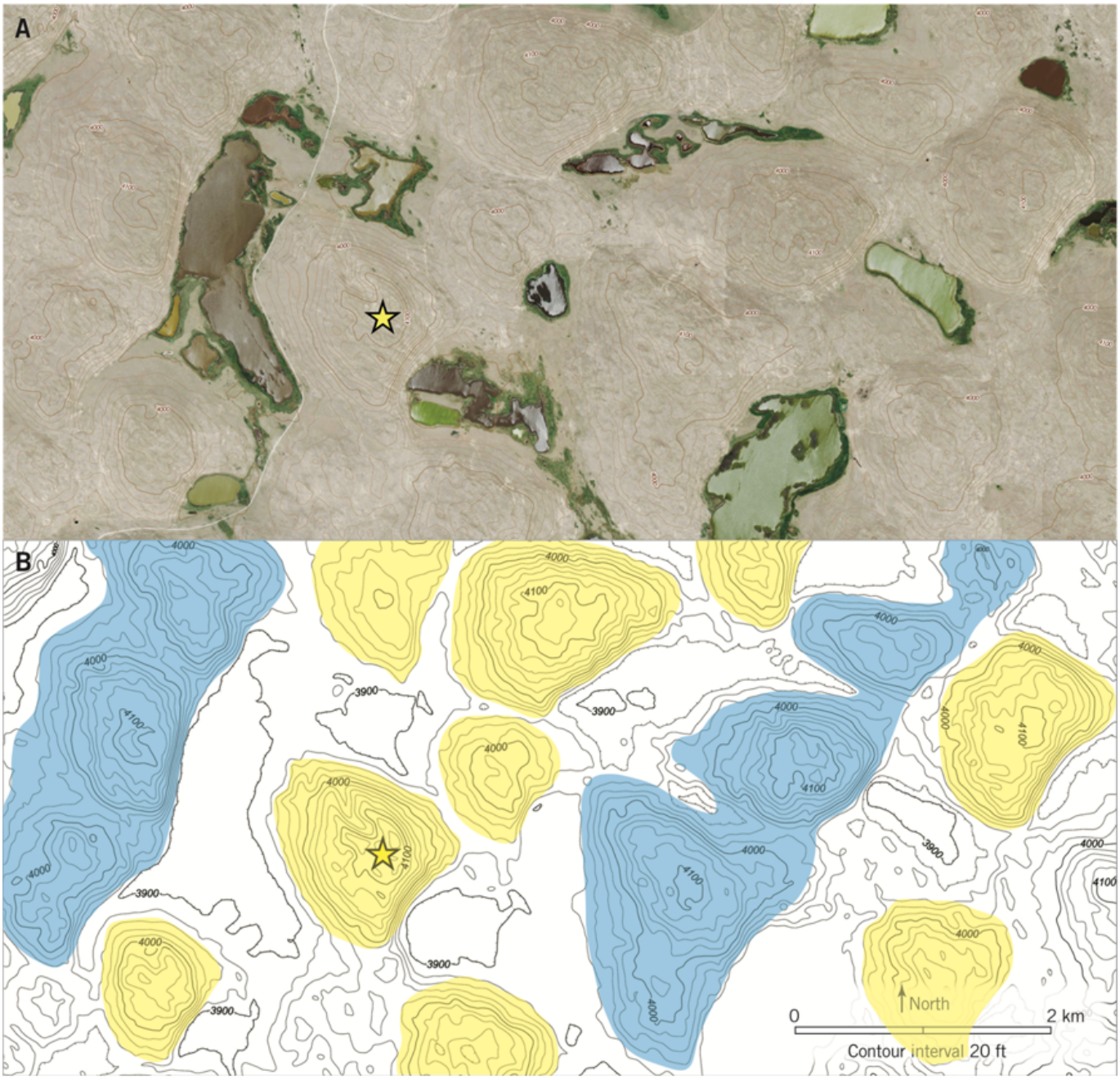

Figure A14.2.2

C REFLECT & DISCUSS Many cities in central and eastern Nebraska rely on groundwater for consumption, industry, and pleasure. As these cities continue to grow and their use of groundwater increases, what effect might this have on the environments and people of the Sand Hills?

the groundwater level may drop. this would causy the ponds in this area to diminish or disappear.

Activity 14.3

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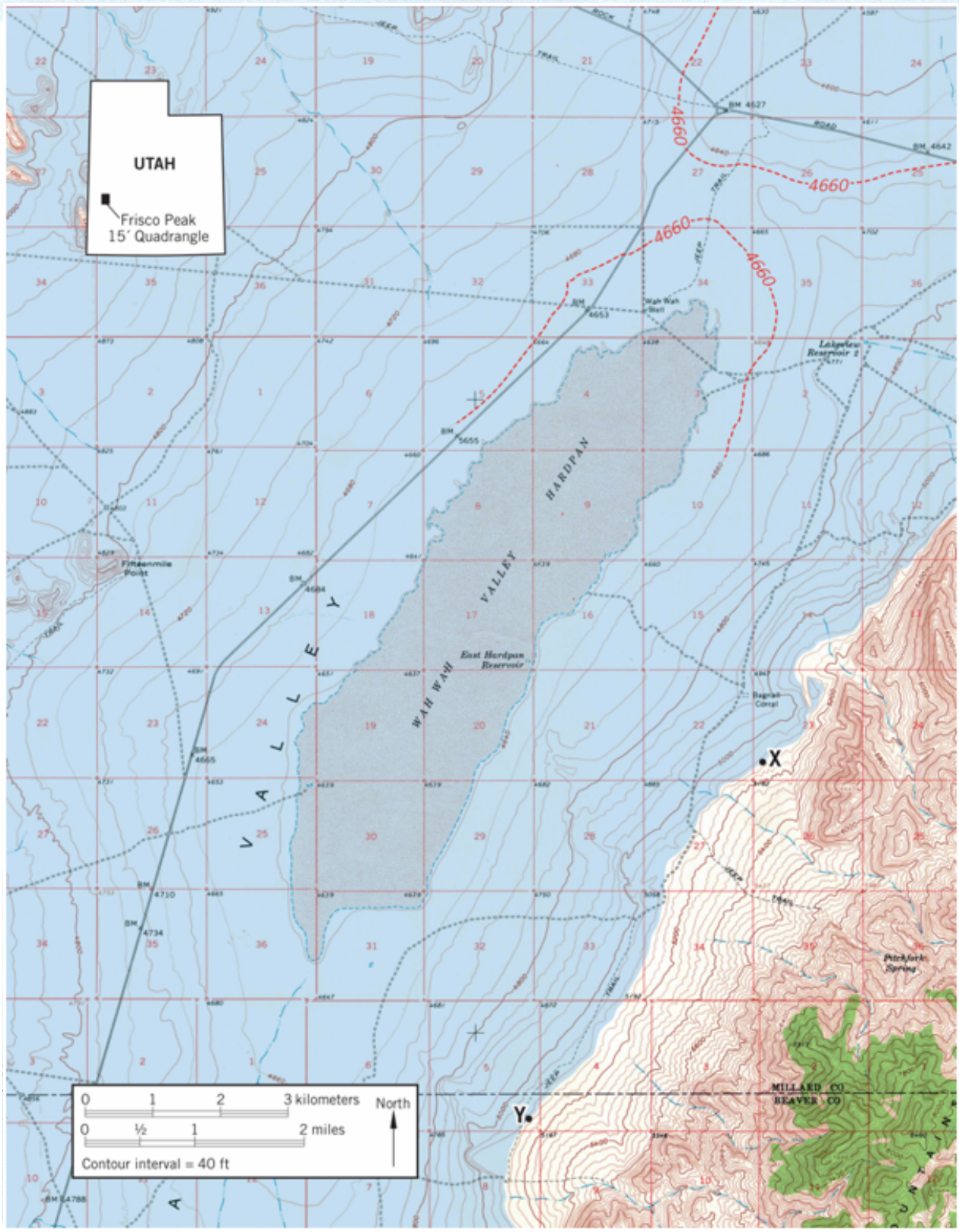

Figure A14.3.1 Part of the USGS 15-minute topographic quadrangle map of Frisco Peak, UT (1960).

A What specific type of feature is the Wah Wah Valley Hardpan? It is a playa

B If the Wah Wah Valley Hardpan were to fill with water, how deep could the lake become before it overflows to the northeast along the jeep trail, near the red section number 27 located just above the northeast end of the hardpan in **Fig. A14.3.1**? Show your work.

Valley floor is approx 4637ft. and the high point between valleys is approx 4670ft

4670 ft
- 4637 ft
33ft deep

C On **Fig. 14.5**, notice the curves that resemble topographic contours such as the one along which the points labeled X and Y are located. These curves are low, step-like terraces that go all around the valley, like bathtub rings. How do you think these terraces formed? they are ancient shorelines (cut-eroded by waves).

D On the aerial photo (**Fig. 14.5**) and topographic map (**Fig. A14.3.1**), what evidence can you identify for a former deeper lake—an arm of Lake Bonneville—in Wah Wah Valley at locations X and Y? What was the elevation of the upper surface of that ancient lake? 5100 ft On the aerial photo, X and Y are located on the highest ancient shoreline. the change in color and the impact on alluvial fans are additional evidence.

E On the topographic map, use a blue colored pencil to draw where the shoreline of ancient Lake Bonneville was when the lake filled to its highest elevation using your answer for part **D**. Then use the blue pencil to color in the area that used to be under water. See previous page

F Studies by geologists of the Utah Geologic Survey and USGS indicate that ancient Lake Bonneville stabilized in elevation at least three times before present: 5100 ft. about 15,500 years ago, 4740 ft. about 14,500 years ago, and 4250 ft. about 10,500 years ago.

1. What is the age of the lake level that you identified in part **D**? 15,500 years old

2. Modern Great Salt Lake has an elevation of about 4200 ft. and is 30 ft. deep. It occupies part of the large basin that was once filled by Lake Bonneville. How deep was Lake Bonneville at the current location of the Great Salt Lake when Lake Bonneville was at its highest level?

5100ft ancient surface
- 4170ft current lake floor (bottom)
930 feet deep

G **REFLECT & DISCUSS** Explain how the climate must have changed in Utah over the past 17,000 years to cause the fluctuations in levels of Lake Bonneville investigated above. In your answer, consider the times identified in part **F** and conditions in Utah today.

there must have been fluctuations between times of high rainfall and glacier meltwater, and times of more arid conditions.

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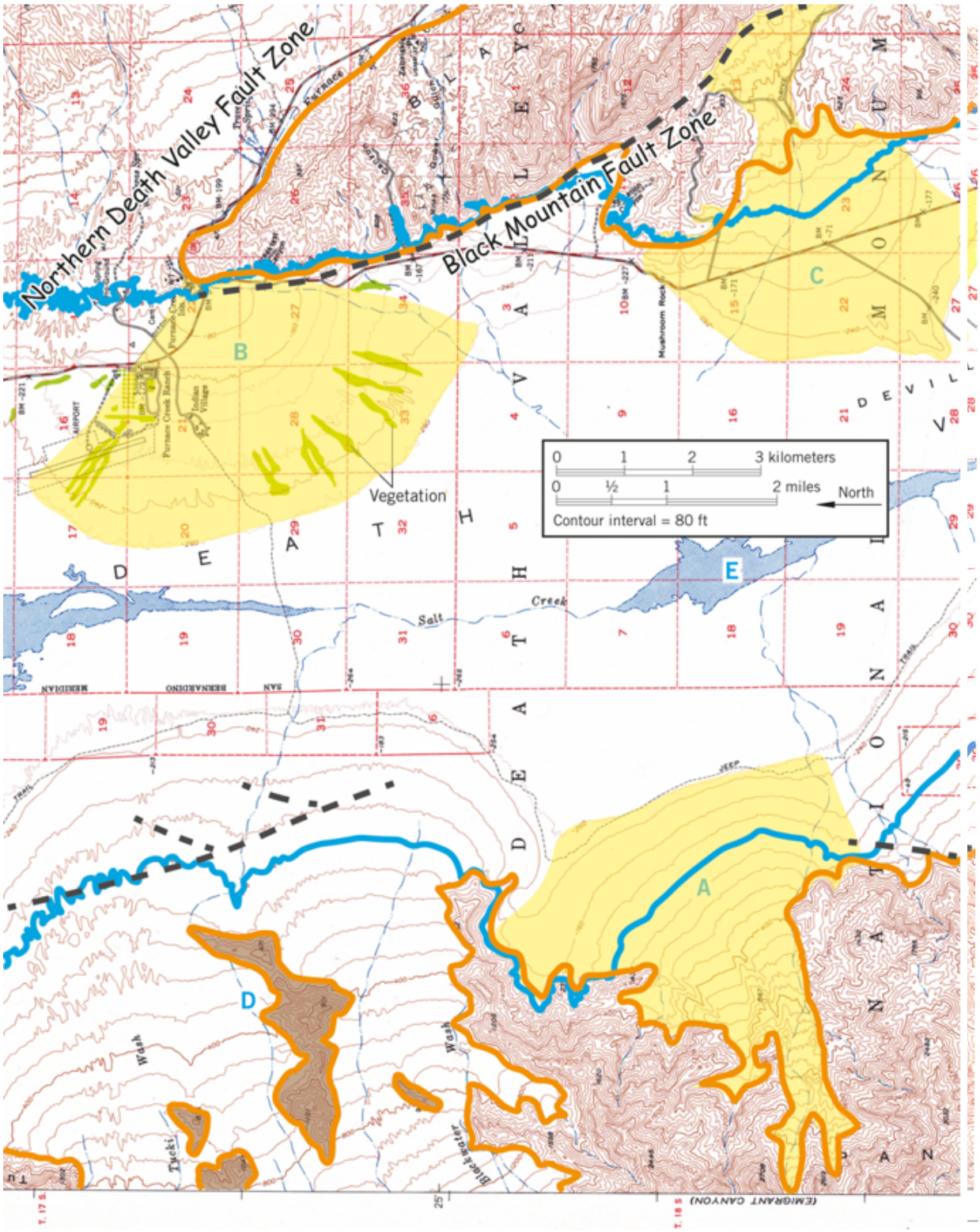

Figure A14.4.1 Part of the USGS 15-minute topographic quadrangle map of Furnace Creek, CA (1952).

A Analyze the topographic map in **Fig. A14.4.1** and complete the following tasks. Refer to **Fig. 14.8** for guidance.

1. Carefully and neatly color alluvial fan A yellow, including the places at the top (upslope end) of the fan where it extends up into two canyons. Do the same for alluvial fans B and C. See previous page
2. Color the inselbergs brown in the vicinity of location D. "
3. Color the 00 (sea level) topographic contours blue on both sides of the valley. "
4. Make an orange line along the downhill edge of the *mountain front* (**Fig. 14.7**) on both sides of the valley. "
5. What is the elevation of the lowest point on the map? _____ ft.

the lowest point marked is -265 feet.

B Notice the intermittent stream that drains from the upstream end of the alluvial fan system A (that you have already colored yellow) to the playa at E. How would the grain size of the sediments along this stream change as you walk downslope from the highest part of the fan, up in the canyons, to the playa (E)? Why?

the stream would slow starting where it exits the mountain front. Alluvial grain size would decrease as you walk down the fan.

C Carefully examine **Fig. A14.4.1** for evidence of normal faults on either or both sides of Death Valley. Refer to **Fig. 14.10** for ideas. Draw a dark dashed line with a regular pencil or a black colored pencil wherever you think a normal fault might reach the ground surface on either the east or west sides of the valley. See map previous page.

this is difficult to determine!

D Almost a decade of measurements indicate that relative to the stable interior of the North American Plate (NAD08), GPS site P462 moves toward azimuth ~309.7° at a rate of 3.90 mm/yr., and site P596 moves toward 315.5° at 5.79 mm/yr. (yellow arrows in **Fig. 14.10**). Both GPS sites are part of the Plate Boundary Observatory developed as part of the EarthScope Project. Relative to P462, GPS site P596 moves toward 327.1° at 1.95 mm/yr. (orange arrow in **Fig. 14.10**).

1. Block faulting typical of the Basin and Range tends to involve stretching roughly perpendicular to normal faults as shown in **Figs. 14.7A–D**. Extension in a pull-apart basin tends to be roughly parallel to strike-slip faults as shown in **Figs. 14.7E–F**. Based on the orange arrow originating at GPS site P596 in **Fig. 14.10** that shows the motion of the west side of Death Valley relative to the east side, is the current widening of Death Valley more likely related to Basin-and-Range block faulting or to development of a pull-apart basin? Explain your reasoning.

Pull-apart. Based on GPS (plate motion) being parallel to the strike-slip faults.

Not assigned

2. The strike-slip faults to the north and south of Death Valley have been active for around 12 Myr (**Fig. 14.10**). If P596 moved in the same direction at the same rate relative to P462 for 12 Myr, how far would P596 move? 23 km
About how far is it from the bedrock on the east side of the valley to the top of the alluvial slope on the west side of the valley measured parallel to the orange arrow and the orange strike-slip faults? 27 km

1.95 mm/yr × 12,000,000 yr × 0.000001 km/yr = 24 km approx

Distance = (60mm × 10km) ÷ 2.25mm = 27 km approx

E **REFLECT & DISCUSS** Notice that people chose to build a ranch on alluvial fan B even though this entire region is dry land. What do you think was the single most important reason why those people chose alluvial fan B for their ranch instead of one of the other fans?

there is a spring there!