How Did These Ocean Features and Continental Margins Form?

The terrain below contains various features on the seafloor, as well as parts of three continents. Some general observations of each feature provide clues about what that feature is. You will use this information to interpret how each feature formed, what the area was like in the past, and how it will look in the future.

Goals of This Exercise:
- Observe the terrain and make observations about the shape, size, and character of each feature.
- Use the general descriptions to determine which features are present in different parts of the terrain.
- Interpret how each feature formed and use this information to infer the present-day plate tectonics of the area.
- Use all the information to reconstruct what the area probably looked like 20 million years ago and what it will look like 20 million years into the future.

1. This figure shows a region approximately 1,000 km (600 mi) wide. The seafloor is shaded according to depth, with lighter blue colors indicating shallower areas. Numbers indicate the isotopic ages of volcanic rocks in millions of years before present (labeled Ma). The lowest seafloor is part of the abyssal plain, and the only age on it is 140 Ma, in the middle of the ocean.

2. A broad oceanic plateau rises from deep water and locally forms small islands. Samples collected by drilling and dredging are mostly basalt and are dated at 40 million years. A linear chain of islands and seamounts extends from the oceanic plateau toward the southeast. The islands and seamounts are shaped like volcanoes and consist of volcanic rocks, mostly basalt. The ages of the volcanic rocks decrease to the southeast. A basaltic shield volcano at the southeast end of the chain is still active.

3. A curved belt of volcanic islands flanks a deep oceanic trench on the east. Most of the volcanoes consist of andesite and show evidence of recent explosive eruptions. Most islands have been volcanically active for 35 to 50 million years, as shown by the age range for volcanic rocks in several islands.

4. There is a narrow sea between the volcanic islands and a continent to the west. In the center of the sea is a low ridge, whose axis contains a rift valley and evidence of active submarine eruptions of basalt. The axis of the ridge has jogs along some type of fractures.

5. The western continent contains a narrow shelf offshore. There is no trench, evidence of recent volcanoes, earthquakes, or mountain building along this edge of the continent. The oldest oceanic crust next to the continent is 20 million years old.
Procedures
Use your observations of this region to complete the following steps, entering your answers on the worksheet or online.

1. Observe the terrain and determine which types of features are shown (e.g., mid-ocean ridge, island arc, etc.).
2. Based on the descriptions, briefly describe or identify how each feature probably formed.
3. Identify the main geologic features shown on the cross section along A–A’.
4. In the appropriate place on the worksheet, draw a cross section along the front of the terrain. Show your interpretations of the plate geometries and different types and thicknesses of crust and lithosphere.
5. Describe what the area might have looked like 20 million years ago based on the ages and relative motions of the plates. Draw a very simplified map of your interpretation on the worksheet.

Your instructor may also ask you to complete the following steps. If so, enter your answers in the appropriate tables on the worksheet or online.

6. Interpret whether adjacent features are related to one another using their relative positions and ages.
7. Predict what the area will look like 20 million years into the future. Draw a simplified map of your interpretation on the worksheet.

6. The shelf surrounding the central continent is broad and shallow, extending several hundred kilometers out from the shoreline. The edge of the shelf shows no evidence of earthquakes or active faulting. Several large canyons are cut into the shelf and lead down to large piles of sediment on the abyssal plain. The continent has fairly subdued topography.

7. To explore for oil, geologists used seismic surveys to investigate the shelf of the central continent. A geologic cross section summarizing these results is presented below for the line A–A’ (shown on the map). All sedimentary layers are Cenozoic (younger than 65 million years).

8. A narrow ocean separates the central and eastern continents. In the center of the ocean there is a prominent submarine ridge that rises several kilometers above the surrounding seafloor. The axis of the ridge has a well-defined rift and shows evidence of recent volcanism. Samples dredged from the ridge are basalt. Most samples close to the ridge are very young (less than 5 million years). The oceanic crust is older farther from the ridge, but is no older than 25 Ma between the central and eastern continents.

9. The eastern continent is flanked by a shallow shelf covered with sediments. There is no evidence for earthquakes, active faulting, or volcanism. The oldest oceanic crust next to the continent is 20 to 25 million years old.