ERA	PERIOD	EPOCH	IMPORTANT GEOLOGIC EVENTS IN MASSACHUSETTS
	million years ago		
CENOZOIC	QUATERNARY	Pleistocene	Wisconsinan ice age begins 80,000 years ago and covers Massachusetts between 25,000 and 15,000 years ago. Marine sediments deposited during Sangamon interglacial stage. Remnant till of Illinoian ice sheet deposited 140,000 years ago.
		1.6	
	TERTIARY	Pliocene	
		5	
		Miocene	Deposition of glauconitic sands, coarse sands, and gravel.
		24	
		Oligocene	
		36	
		Eocene	
		58	
		Paleocene	
MESOZOIC		65	
	CRETACEOUS		Intrusive rhyolite in northeastern Massachusetts. Deposition of variegated clays, silts, and lignite coal at Gay Head. Marine sediments of coastal plain deposited far inland.
		145	
	JURASSIC		Rift volcanism initiates opening of Atlantic Ocean and breakup of Pangaea. Rift basins open in the Connecticut Valley region. Basalt flows and dikes, including Medford dike. Deposition of fossiliferous redbeds. Dinosaurs leave tracks.
		208	
	TRIASSIC		Deposition of coarse clastic sediments.
		245	
PALEOZOIC	PERMIAN		Final assembly of Pangaean supercontinent during the Alleghanian orogeny, 275 to 250 million years ago.
		286	
	PENNSYLVANIAN		Narragansett Basin and other coal basins form in Avalon terrane.
		320	
	MISSISSIPPIAN		Rapid uplift of Nashoba terrane.
		360	
	DEVONIAN		Continued sedimentation. Acadian mountain building event—Merrimack, Nashoba, and Avalon microcontinents collide with Laurentia and its associated volcanic island chains. Collision produces extensive plutonism and dome uplift. Rift plutonism and volcanism in Avalon terrane.
		417	
	SILURIAN		Initial stage of Acadian mountain building event. Sedimentary rocks deposited unconformably on Bronson Hill volcanic belt of Laurentia. Edge of Avalon terrane sinks beneath Nashoba terrane in subduction zone, generating more Burlington mylonite. Volcanic and plutonic activity begun in Ordovician time continues to build Nashoba and Merrimack terranes.
		443	
	ORDOVICIAN		Shelburne Falls and possibly Bronson Hill volcanic island chains, which formed along margin of Laurentia, collide with continent in the Taconic mountain building event. Rifts open in Avalon and produce alkaline plutonic activity.
		495	
	CAMBRIAN		Fossiliferous continental shelf sediments—Stockbridge marble and Cheshire quartzite—deposited on Laurentian margin. Trilobite-bearing sediments deposited on margins of Avalon.
		545	
PRECAMBRIAN	PROTEROZOIC EON		Avalon and associated microcontinents separate from Gondwana 550 million years ago. Boston rift basin forms in Avalon about 570 million years ago. Major faulting and shearing along margin of Gondwana forms the Burlington mylonite. Magmas from the Avalon volcanic chain intruded the mylonite, forming the Dedham and Milford granites. Rodinia supercontinent completely assembled by 750 million years ago, then breaks up, giving rise to Gondwana supercontinent. Grenvillian mountain building event affects Grenville gneisses on eastern margin of Laurentia, 1.2 to 1.1 billion years ago.
		2,500	
	ARCHEAN EON		

Geologic timescale. —Geologic times from Palmer, 1983; Tucker and McKerrow, 1995; Bowring and others, 1993

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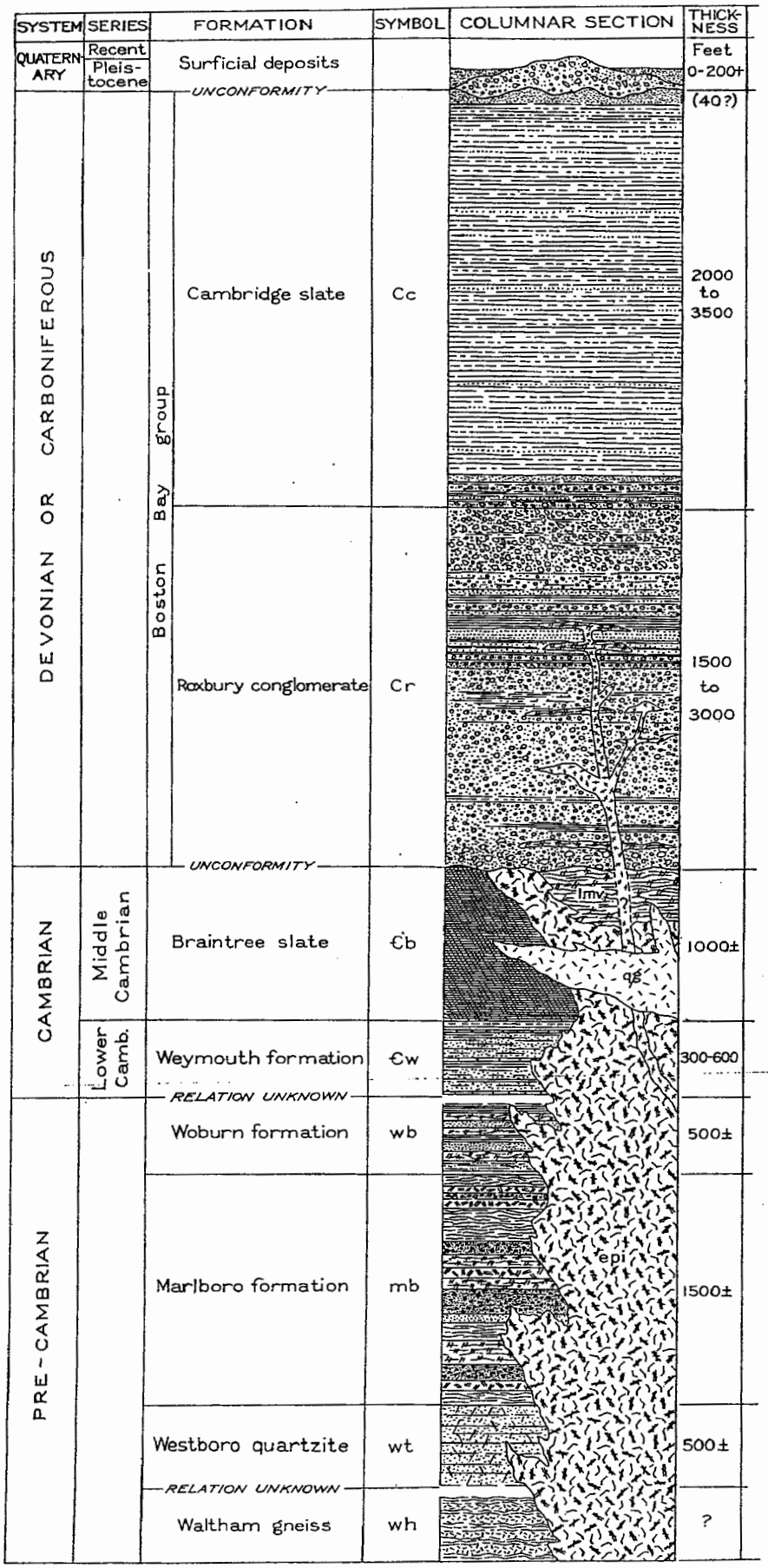
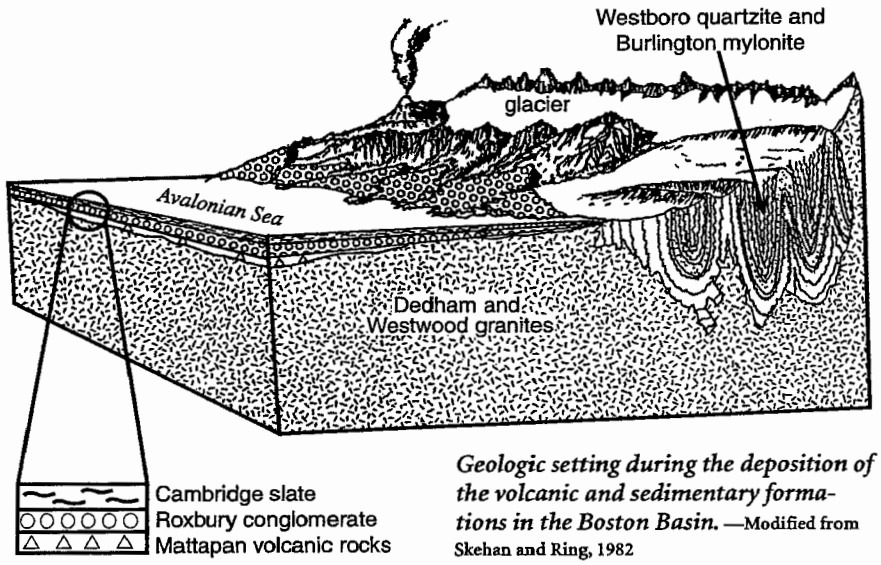


COLUMNAR SECTION FOR THE BOSTON AREA



Geologic setting during the deposition of the volcanic and sedimentary formations in the Boston Basin. —Modified from Skehan and Ring, 1982

Mattapan, Lynn, and Brighton Volcanic Rocks. The Mattapan and Lynn volcanic rocks erupted about 596 million years ago from the Avalon volcanoes. These rocks include fine-grained rhyolites, dark to light green lavas, and ashflows that include crystal tuffs, breccias, and mudflows. The Mattapan volcanic rocks are present southwest of Boston and the Lynn volcanic rocks north of Boston. Native Americans fashioned the rhyolites into tools and arrowheads.

The Brighton volcanic rocks, also from the Avalon volcanoes, consist of highly altered basaltic lavas and ashfalls that probably coated the landscape as the Boston Basin formed. They are typically below the Boston Basin sediments or interlayered near their base. Both the Brighton volcanic rocks and the associated 589-million-year-old quartz diorite dikes that intrude the Westwood granite southwest of Boston have been hydrothermally altered.

Roxbury Conglomerate. The nearly 2,000-foot-thick Roxbury formation consists of conglomerate, shale, sandstone, quartzite, arkose, and altered basaltic volcanic rocks. The conglomerate is often called puddingstone. Oliver Wendell Holmes (1809–1894) described the appearance of the pebbles in the fine-grained matrix as "plums in a pudding." His poetic theory of the origin of the puddingstone is as delightful as it is imaginative.

In Holmes's 1830 poem "The Dorchester Giant," the giant's unruly children:

> . . . flung [the pudding] over to Roxbury Hills,
> They flung it over the plain

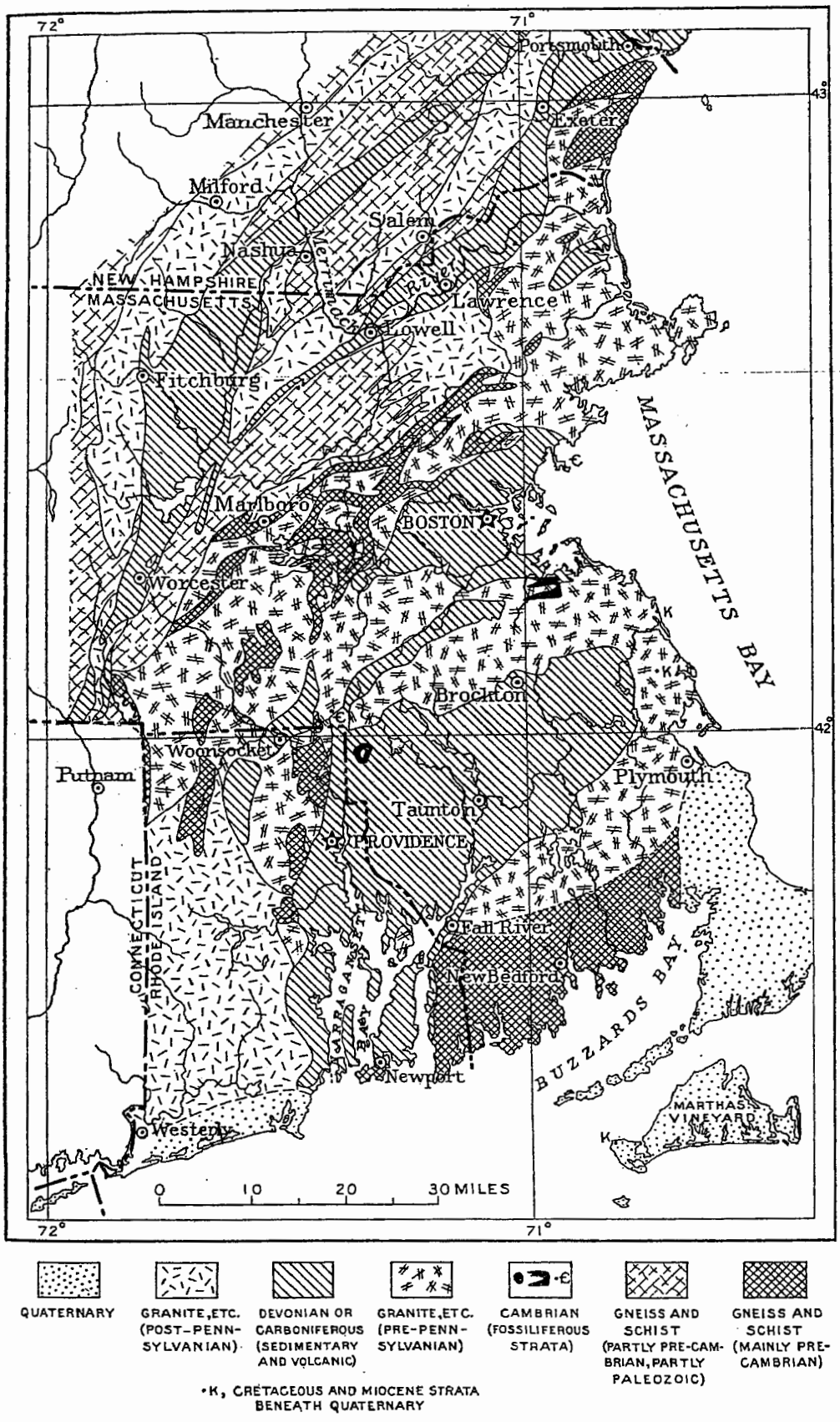
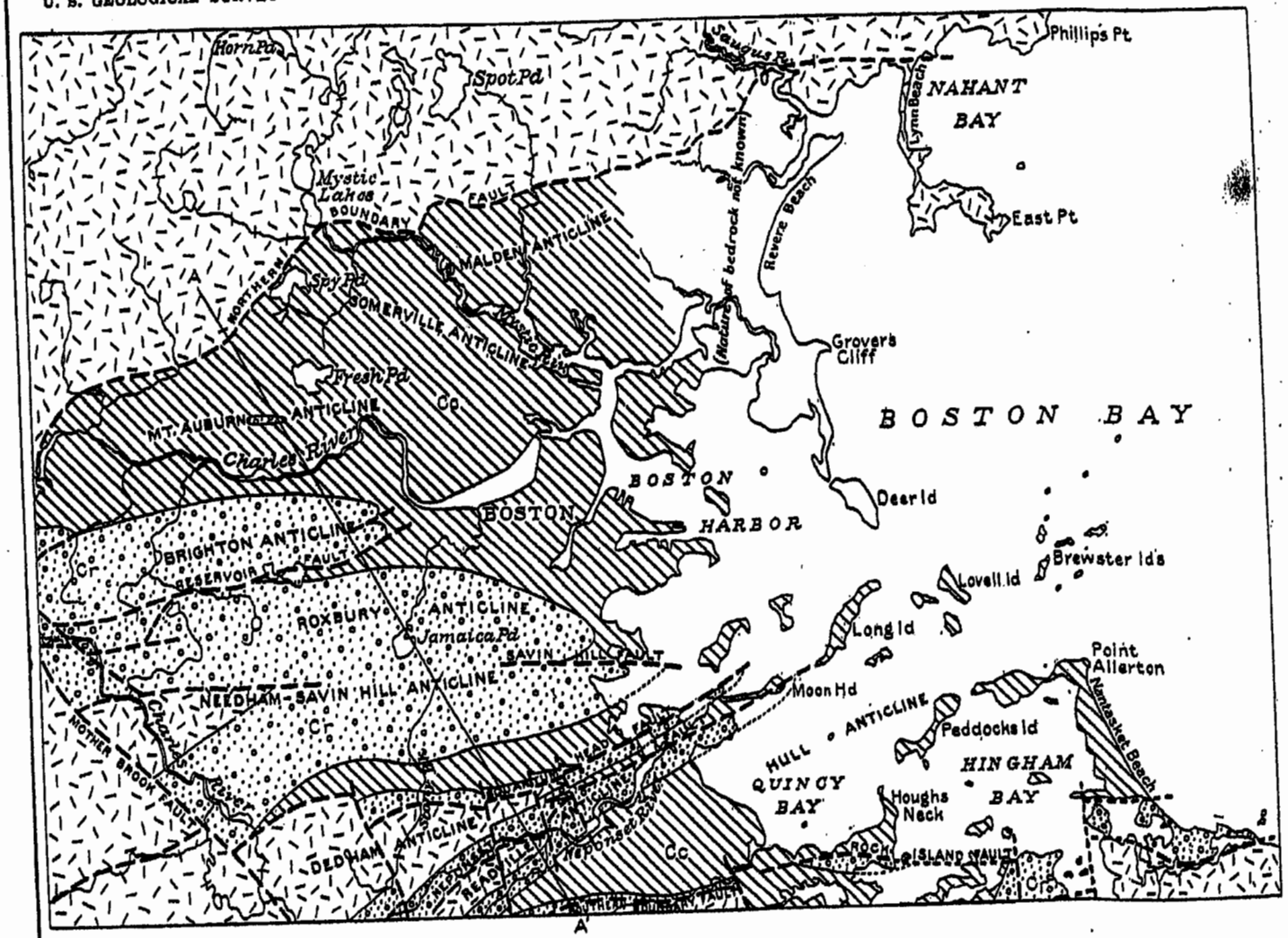
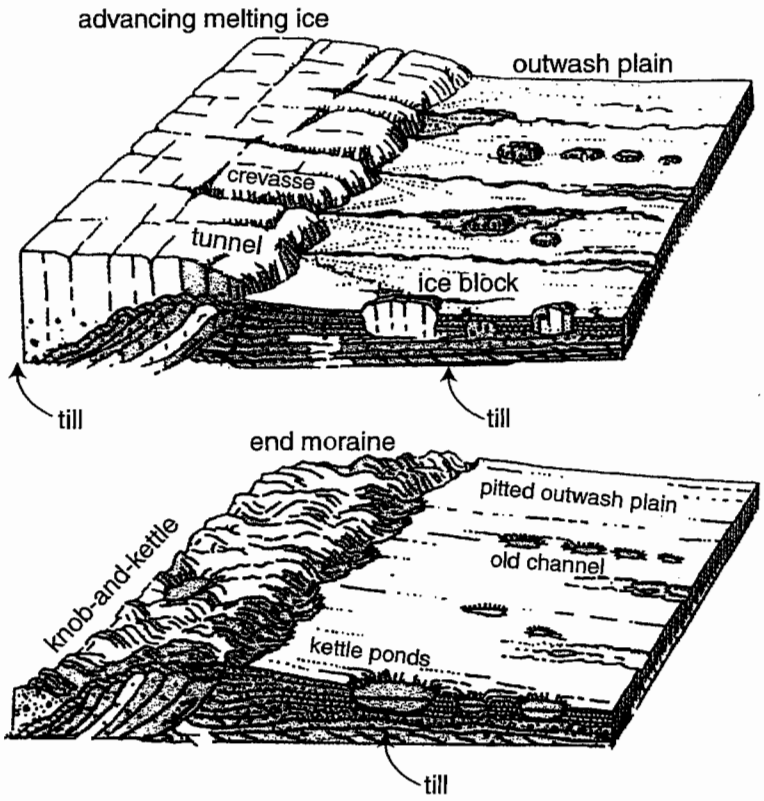


FIGURE 2.—Generalized geologic map of southeastern New England



GENERALIZED GEOLOGIC MAP AND SECTION OF BOSTON BASIN

111895—82. (Face p. 26.)



Formation of a pitted outwash plain. Meltwater braided streams bury residual ice blocks that later melt. Overlying outwash sediments collapse into kettle holes and kettle ponds. —Modified from Strahler, 1988; thrust sheets based on Oldale and O'Hara, 1984

Kettles Are Not Just for Cooking

Blocks of ice left behind when the glacier melted back from Martha's Vineyard and Nantucket lay scattered between the terminal moraines on The Islands and the new end moraines—Buzzards Bay moraine and Sandwich moraine. The braided streams partially or completely buried these ice blocks. When they eventually melted, the overlying layers of outwash sand sagged and collapsed to form kettle depressions. The collapsed deposits form irregular hilly knobs. Knob-and-kettle topography is well developed between Orleans and Nauset Beach. Most of the numerous, delightful ponds and lakes of Cape Cod are kettles. In forested areas, you can still recognize kettles because the pattern of treetops often mimics the shape of the kettle hole.

The size of a kettle mirror
responsible for the depressio
Harwich Townships, is the l
acres. Water depths in kettle
more than 80 feet. Cliff Pond
Brewster Township, is the de
feet above sea level and the
sand probably partially fille
sponsible for Cliff Pond may

Cockle Cove in South Cha
the end of the last ice age, t
Nantucket Sound. Longsho
protects the embayment.

Sandy Neck Dunes

The large and unstable d
Massachusetts only by thos
Deforestation and off-road v
ity of the dunes at Sandy N
Neck Beach.

*View looking southeast acro
Mashpee pitted plain, from th*