31 A Fascinating Gift from Volcanoes: The Fairy Chimneys and Underground Cities of Cappadocia

Attila Çiner and Erkan Aydar

Abstract

Cappadocia, at the heart of the Central Anatolia Plateau in Turkey, is famous for its unusual volcanic landscape and rock dwellings. The formation of this landscape dates back to the late Miocene epoch (~ 10 Ma) (Ma = Million years) when ignimbrites and pyroclastic deposits started to spread out from a few volcanic centres over an area of 20.000 km^2 centred on the plateau. The volcanism continued for several millions of years and laid down thick and colourful ignimbrite layers. The evolution of the Cappadocian landscape is governed by the uplift of the plateau since late Miocene times. Gently sloping plateaus formed by the surface of volcanic pyroclastic flows are later dissected, usually along fractures of soft-unwelded ignimbrites, to form mushroom-like, cone-shaped structures known locally as "fairy chimneys". Ancient populations also used the ignimbrites to carve their houses, churches and even underground cities. This unique cultural and morphological heritage site was included in the UNESCO World Heritage List in 1985 and today is one of the most visited regions of Turkey.

Keywords

Cappadocia • Fairy chimneys • Hoodoos
Volcanoes • Ignimbrites • Tourism

31.1 Introduction

Situated in the Central Anatolian Volcanic Province (CAVP) in the middle of the Anatolian Plateau in Turkey (Fig. 31.1), Cappadocia with its strange and spectacular landscape looks like another planet. Peculiar landforms called fairy chimneys, vast plains, smooth hills, gorgeous valleys and rising volcanoes exposing an amazing harmony of colours and shapes, man-made troglodyte settlements, painted churches and monasteries and underground cities all make this vast region unmatched worldwide. Cappadocia was included in the UNESCO World Heritage List in 1985 and since then millions of tourists have visited the area to appreciate its unique cultural and morphological heritage.

31.2 Geological and Geomorphological Setting

The CAVP is composed of Upper Miocene-to-Holocene ignimbrites, volcanic ash deposits and lava flows alternating with fluvio-lacustrine sediments that cover ~20.000 km^2 (Le Pennec et al. 1994; Aydar et al. 2012) (Fig. 31.1). The Tuz Gölü Fault to the west and Ecemiş Fault to the east as well as two Quaternary stratovolcanoes, namely Hasandağ (3267 m) to the west and Erciyes (3917 m) to the east, delineate the Nevşehir plateau where the average altitude reaches 1400 m above sea level (Aydar et al. 2012).

Morphologically the CAVP is formed of plateaus cut in places by valleys on the slopes of which fairy chimneys are most common (Fig. 31.2). To the north, the Kızılırmak River, which is the longest river (1355 km) within the borders of Turkey, flows within these ignimbrite sequences and finally reaches the Black Sea. Channel deposits of this river are also often found lying unconformably on these ignimbrites and their intercalated lacustrine deposits.

From a geological standpoint, the pre-volcanic basement of the CAVP is composed of plutonic rocks (mainly granite

A. Çiner (✉)
Eurasia Institute of Earth Sciences, Istanbul Technical University, 34469 Maslak, Istanbul, Turkey
e-mail: cinert@itu.edu.tr

E. Aydar
Geological Eng. Dept, Hacettepe University, 06800 Beytepe, Ankara, Turkey
e-mail: eaydar@hacettepe.edu.tr

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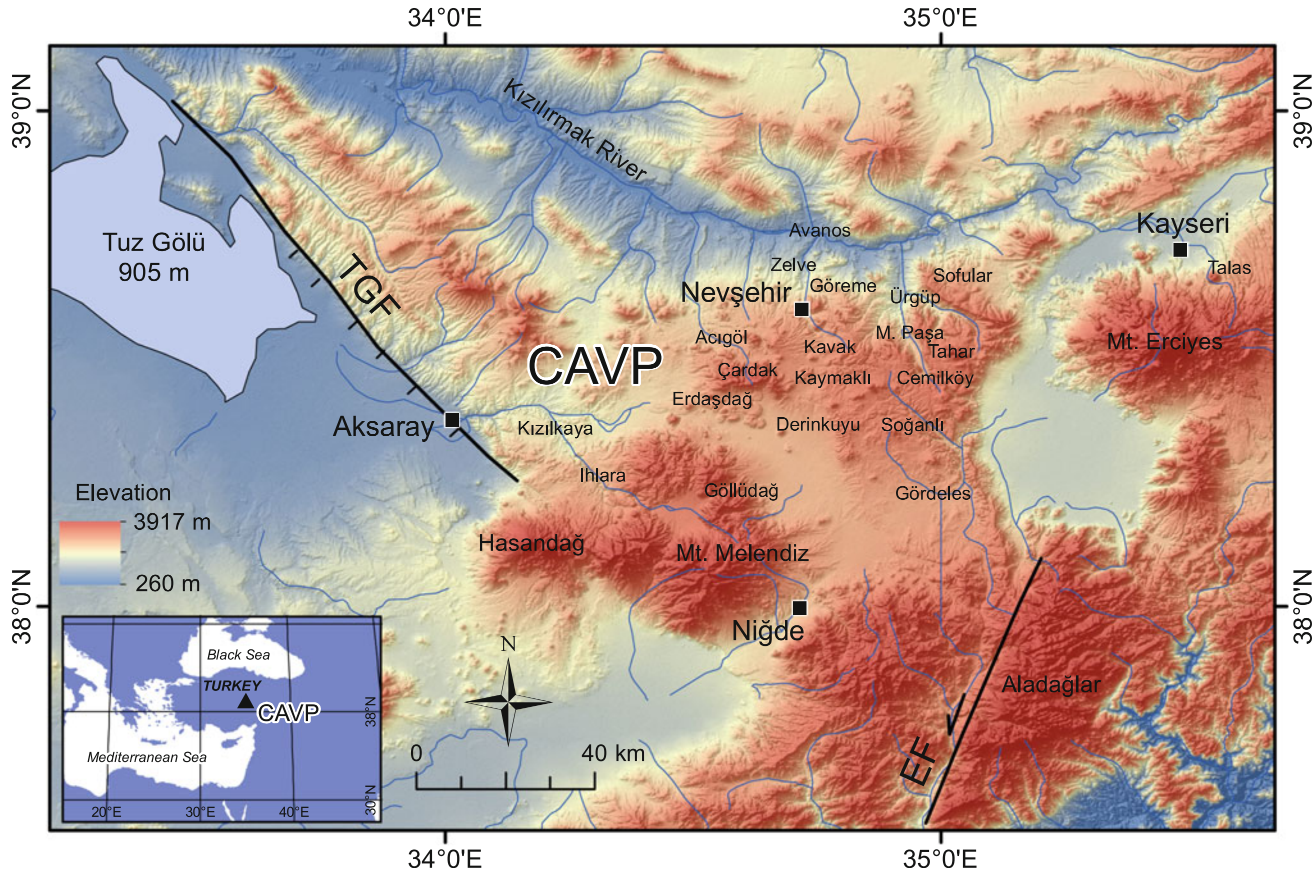


Fig. 31.1 Digital elevation model of the Central Anatolian Volcanic Province (CAVP). TGF: Tuz Gölü Fault, EF: Ecemiş Fault

and gabbro) of Cretaceous age (Aydar et al. 1995, 2012) and metamorphic rocks of the Central Anatolian Crystalline Complex (Aydar et al. 1995; Dilek and Sandvol 2009). The convergence of the Afro-Arabian continent with the Eurasian plate since late Miocene times is responsible for initiation of the widespread and intense continental volcanic activity, which started in Cappadocia ca. 5 Ma (Innocenti et al. 1975; Aydar et al. 1993, 1995; Piper et al. 2002). Subcrustal detachment–delamination of lower crust is thought to be responsible for the volcanic activity that ultimately formed the Cappadocian plateau under the influence of extensional tectonic regime (Aydar et al. 2010). As a result, numerous large-volume ignimbrite deposits, Quaternary stratovolcanoes and monogenic centres characterize the CAVP.

31.3 Volcanic Succession

31.3.1 Ignimbrites

The ignimbrites and lava flows in the CAVP were first described by Pasquarè (1968), and the stratigraphy was further refined by numerical ages obtained using various dating techniques (Innocenti et al. 1975; Pasquarè et al. 1988; Le Pennec et al. 1994, 2005; Mues-Schumacher and Schumacher 1996; Temel et al. 1998; Viereck-Götte et al. 2010; Aydar et al. 2012; Agrò et al. 2014). Aydar et al. (2012) recently published $^{40}Ar/^{39}Ar$ plagioclase eruption ages and $^{206}Pb/^{238}U$ zircon crystallization ages, refining the stratigraphy by defining a total of ten ignimbrite sequences following the terminology outlined in Le Pennec et al. (1994) and respecting mostly original names given by Pasquarè (1968) (Figs. 31.3 and 31.4).

These ignimbrite sequences present ages ranging from 10 Ma to Quaternary. They are named, in stratigraphic order from the oldest to the youngest: Kavak, Zelve, Sarımadentepe, Sofular, Cemilköy, Tahar, Gördeles, Kızılkaya, Valibabatepe and Kumtepe Ignimbrites. Several independent pumiceous air-fall deposits, often named after the closest village names or hills, are also found in the region (Aydar et al. 2012; Çiner et al. 2015a) (Fig. 31.1).

The Kavak Ignimbrites are the oldest pyroclastic deposits (<10 Ma) of the CAVP with a total volume of 80 km^3 distributed over 2600 km^2 and reaching 10–150 m in thickness (Le Pennec et al. 1994). Four distinct units alternating with

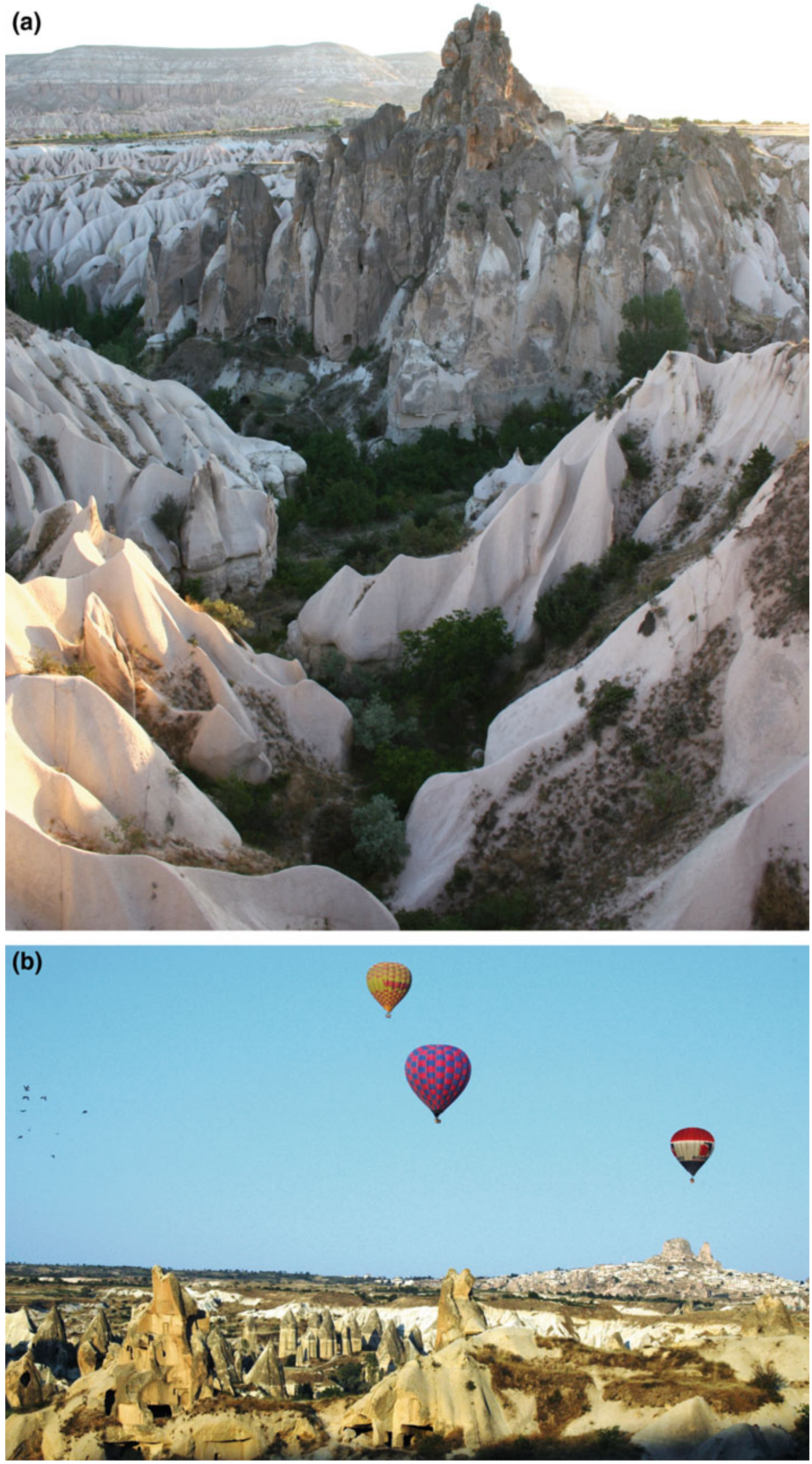


Fig. 31.2 **a** General view of Cappadocian landscape with colourful ignimbrites eroded in places to form valleys and fairy chimneys. **b** Flying with the balloon over the incised valleys where fairy chimneys are developed. Uçhisar village is seen in the background. Photographs by A. Çiner

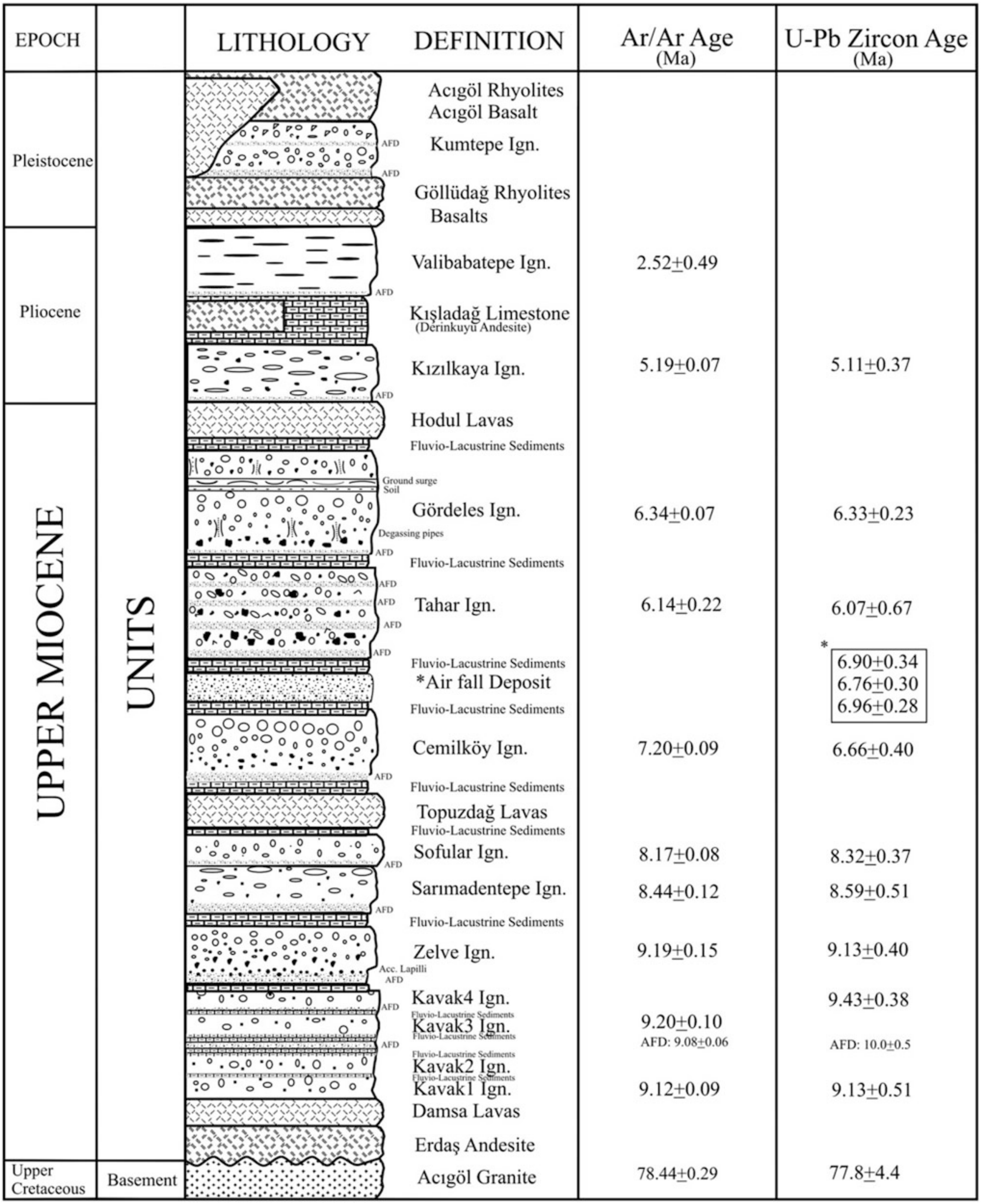


Fig. 31.3 Composite stratigraphic column and crystallization/eruption ages for the CAVP. AFD = Air-fall deposit (from Aydar et al. 2012)

Fig. 31.4 Creamy white Kavak Ignimbrites and Göreme village. Overlying red coloured Zelve Ignimbrite overlain by white, horizontally well-stratified lacustrine sediments at the background. Photograph by A. Çiner

ash-rich fluvio-lacustrine sediments indicating multiple eruptions are defined (Aydar et al. 2012). Most of the man-made caves in Cappadocia are carved within these ignimbrites.

The overlying Zelve Ignimbrite (9.2 Ma) is composed of a white, 5–12-m-thick basal Plinian air-fall deposit almost exclusively composed of glassy rhyolitic pumice (Schumacher and Mues-Schumacher 1996), which in turn is overlain by a single cooling unit of pink ignimbrite with an average thickness of about 60 m. The volume and areal extent of the Zelve Ignimbrite are estimated to be 120 km^3 and 4200 km^2, respectively (Le Pennec et al. 1994). Zelve Ignimbrites are associated with typical fairy chimneys with two-three hats.

The Sarımadentepe Ignimbrite (8.4 Ma) is a very limited ignimbrite outcropping around Mustafapaşa village, mostly to the east and south of Çardak Caldera. It is a yellow-brown coloured welded unit, composed of a basal air-fall layer and an overlying ignimbritic flow.

The following ignimbrite (Sofular) is well constrained by its radiometric age and geochemical signature (Aydar et al. 2012). It is composed of fine-grained air-fall deposit underlain by a single flow unit ~25 m thick.

The Cemilköy Ignimbrite (~7 Ma) is one of the most voluminous and extensive units (300 km^3) of the CAVP. Covering 8600 km^2, it reaches a thickness between 10 and 110 m (Le Pennec et al. 1994). This ignimbrite was sufficiently voluminous to fill-in the pre-existing valleys, creating a volcanic accumulation landscape characterized by smooth surfaces in which later erosion carved the famous Cappadocian fairy chimneys.

The Tahar Ignimbrite is restricted to the eastern part of the CAVP. It is distributed over 1000 km^2 with an estimated volume of 25 km^3, in places reaching 120 m in thickness (Le Pennec et al. 1994). It is generally pale-pink-to-brown coloured and mostly unwelded. However, welding and columnar jointing are prominent around Sofular village.

Gördeles Ignimbrite (6.34 Ma) has an estimated areal extent of ~3600 km^2 and a volume of 110 km^3 with a thickness changing between 7 and 20 m (Le Pennec et al. 1994). Aydar et al. (2012) distinguished two different units (Lower and Upper), which are separated by a paleosol level.

The Kızılkaya Ignimbrite (5.2 Ma) is the most widespread unit in the CAVP and forms a plateau over an area of ~8500–10600 km^2 with a volume of 180 km^3 (Le Pennec et al. 1994; Schumacher and Mues-Schumacher 1996). Locally, its thickness reaches >40–50 m (e.g., the Derinkuyu underground city), peaking at ~80 m (Ihlara Valley), with an average thickness of 15 m. The Kızılkaya Ignimbrite generally consists of two distinct flow units that are often strongly welded with well-developed columnar jointing with cliffs and deeply carved canyon walls (Aydar et al. 2012).

The Valibabatepe Ignimbrite (2.5 Ma) reaches a maximum thickness of 40 m covering 5200 km^2 around Talas at the base of Erciyes Volcano from which it originated (Pasquarè 1968; Le Pennec et al. 1994; Şen et al. 2003).

It has red and black layers in the proximal facies and becomes pinkish and grey in the distal facies.

The Kumtepe Ignimbrite is the youngest ignimbrite of Cappadocia. It erupted during the late Pleistocene in two successive eruptions (Lower and Upper Acıgöl or Kumtepe phases) separated by paleosols or cinder cone deposits (Druitt et al. 1995). Main outcrops are found along the Acıgöl-Nevşehir highway where they cover all older ignimbrites. The zircon ages of these deposits are 206 ka and 163 ka (ka: 1000 years) for the lower and upper units, respectively (Schmitt et al. 2011).

31.3.1.1 The Morphological Expression of the Ignimbrite Succession in Today's Landscape

Among the ignimbrite units defined in the CAVP, fairy chimneys are extensively developed in the Kavak, Zelve, Cemilköy Ignimbrites, easily observable from Avanos towards Mustafapaşa villages, and to some extent in the Kızılkaya and Gördeles Ignimbrites.

Lacustrine deposits made up of carbonate and mudstone together with fluvial deposits frequently alternate with the ignimbrite units. This relationship is well observed at the entrance to the Zelve Valley where several tens of metres thick subhorizontal and continuous white lacustrine sediments overly the Zelve Ignimbrites indicating quiescence periods in the volcanism that normally characterizes the region.

The strongly welded Kızılkaya Ignimbrite, which covers most of the underlying deposits, forms today a large plateau from Soğanlı Valley to the east until Ihlara Valley to the west. Near Ihlara and Kızılkaya villages, well-preserved cooling cracks presenting typical hexagonal-like designs are widely dispatched over the surface of the Kızılıkaya ignimbritic plateau. This structural design evidences the correspondence of the surface of the plateau with the original surface of the volcanic flow. Later during the Quaternary, erosion transformed the flow into separate mesas, which now dominate over fluvial corridors and the rivers.

31.3.2 Quaternary Volcanoes and Monogenic Centres

Cappadocia hosts two Quaternary stratovolcanoes: Hasandağ and Erciyes (Fig. 31.5). Both volcanoes have their own evolutionary history. As they are Quaternary in age they are much younger than the ignimbrites and form an obvious and spectacular contrast with their heights. Additionally, several hundreds of monogenetic vents, such as cinder cones, maars and lava domes decorate the landscape of Cappadocia.

31.3.3 Source Areas

For a long time, it has mistakenly been believed that Cappadocian tuffs or ignimbrites were produced by the dominating volcanoes (Erciyes and Hasandağ) and rhyolitic massive of Göllüdağ volcanoes. However, late Miocene-Pliocene ignimbrites are now known to be the product of calderas that have collapsed and are barely visible (Le Pennec et al. 1994; Froger et al. 1998; Aydar et al. 2012).

31.4 Fairy Chimneys

The so-called fairy chimneys are mushroom-like structures where harder volcanic rocks are underlain by softer rocks. They are probably the most peculiar features of Cappadocia. Fairy chimneys are unique landforms composed of different

Fig. 31.5 Erciyes Volcano, view from South Photograph by Hakan Gün; Atlas Magazine

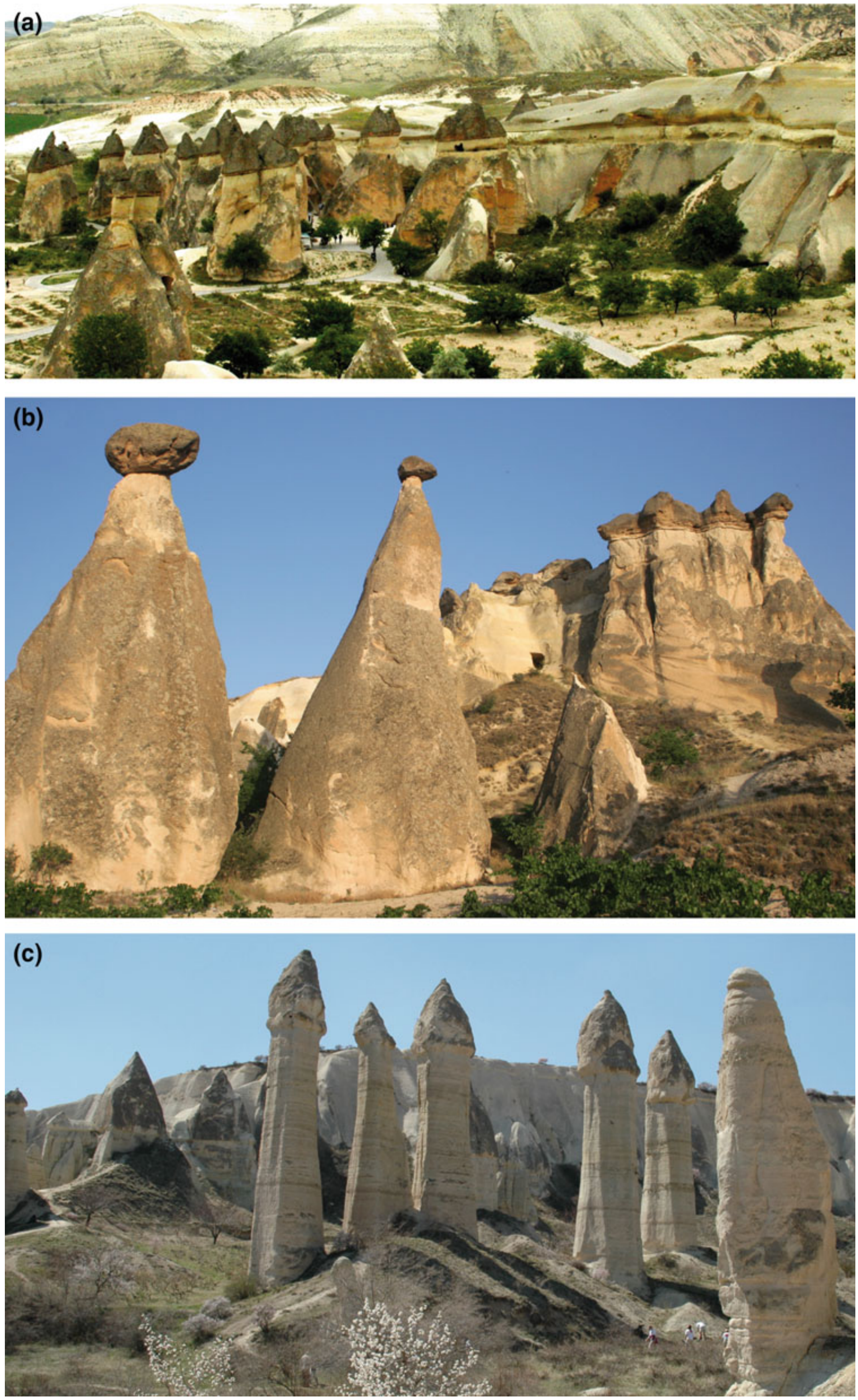


Fig. 31.6 **a** Fairy chimneys near Paşabağ area. While the chimneys on the background to the right of the picture are not fully separated from their cooling fractures, the chimneys in front stand-alone. Once the harder top will fall, the chimneys will erode much faster as is the case for the chimney at the centre of the picture. **b** Another case where completely fairy chimneys start to develop (background), stand-alone (with heads) and heads eroded. **c** "Love Valley" fairy chimneys. Photographs by A. Çiner

ignimbrites, which present variable resistance to erosion (whether by wind abrasion or by run-off incision). Typical fairy chimney forms evoke pillars, columns, towers, obelisks and needles that can reach 50 m in height (Figs. 31.6 and 31.7). Recently paleo-fairy chimneys, observed on a road cut, were also described by Doğan et al. (2018).

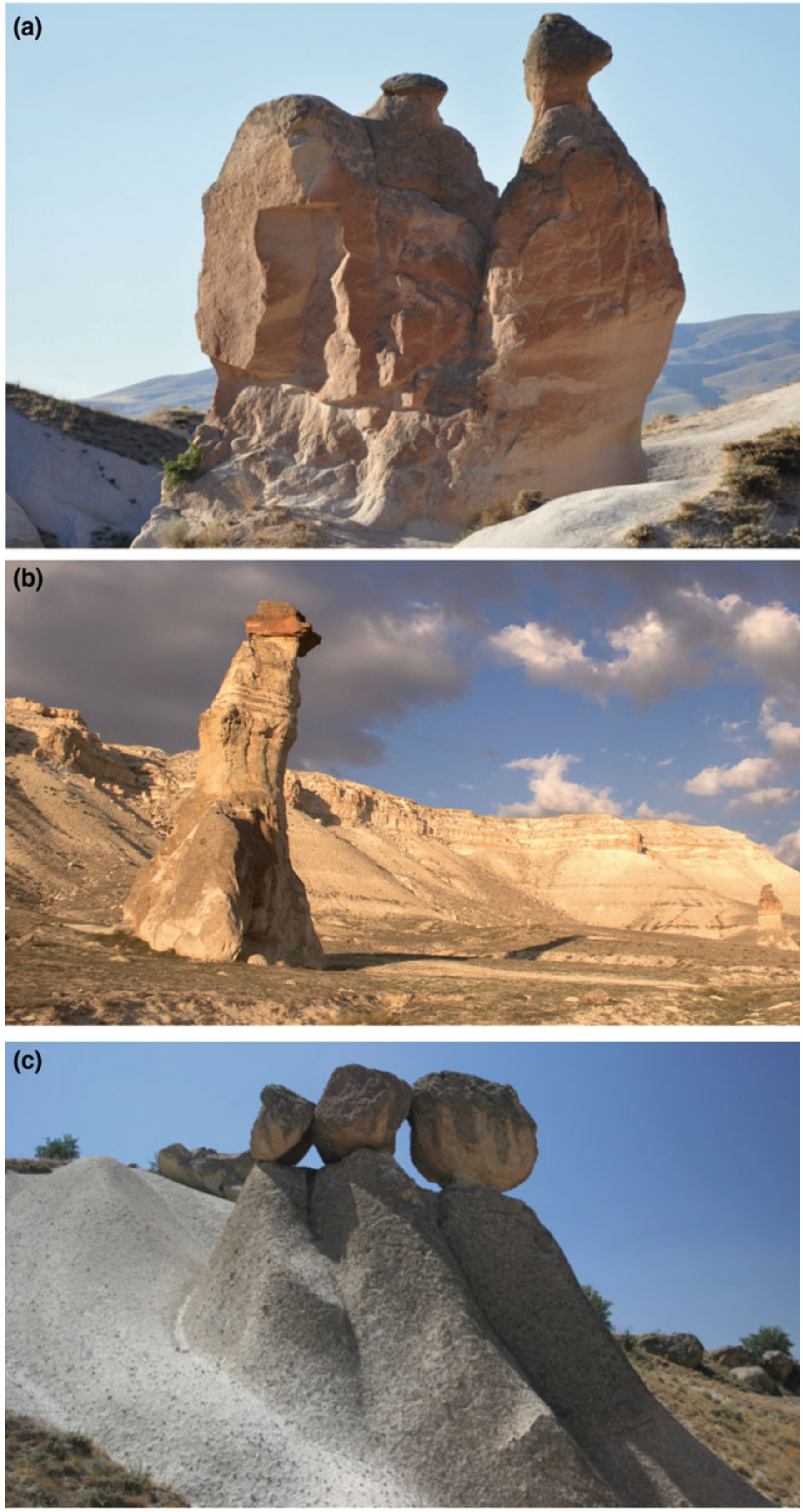
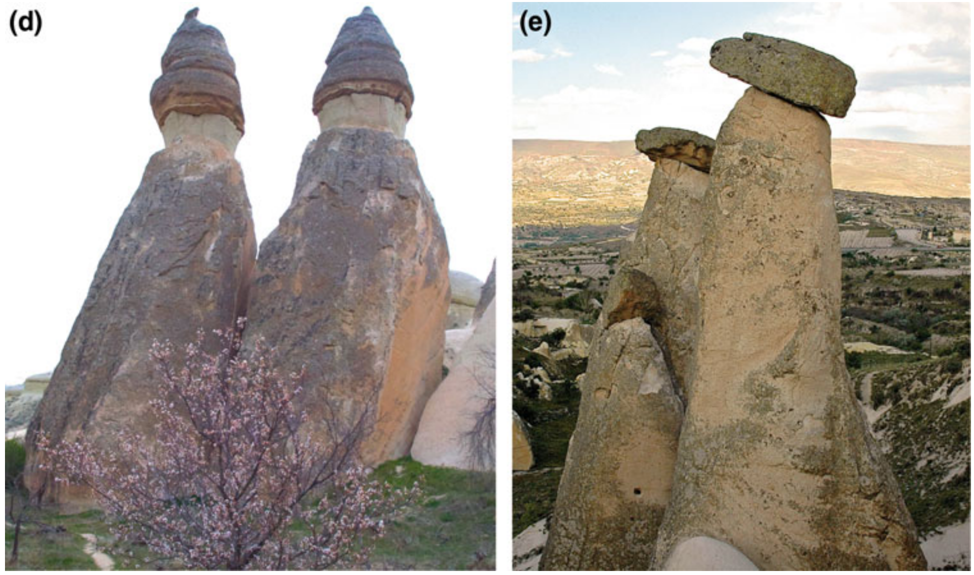


Fig. 31.7 Fairy chimneys types: **a** "Camel" as is locally known is developed within Zelve Ignimbrite. **b** Fairy chimneys can also develop within lacustrine sediments. **c** Cemilköy Ignimbrite forms the base of this fairy chimney, while a rock fallen from overlying Kızılkaya Ignimbrite forms the top. Several other fallen "fairy chimneys heads" are present on the background. **d** Twin fairy chimneys near Zelve. Soft Kavak Ignimbrite is overlain by 1-m-thick lacustrine white mudstone that is in turn overlain by harder Zelve Ignimbrite, which constitutes the top. **e** "Family" as is locally known is developed in Kavak Ignimbrite near Ürgüp village. Photographs by A. Çiner

Fig. 31.7 (continued)



31.4.1 Formation and Erosion

The formation and degradation of the fairy chimneys are controlled by spacing, aperture and strike and dip of discontinuities initially formed by thermal stress (Topal 1995; Topal and Doyuran 1995, 1998; Aydan and Ulusay 2003; Ergüler 2009). The structure of the deposit (lithological differences, uneven grain-size distribution of the powder-to-block-sized elements and the slope gradient on which fairy chimneys are developed) also plays a role.

The evolution of this landscape started with gently sloping plateaus, which have been later differentially eroded, as a response to the continuing uplift of the Central Anatolia Plateau since late Miocene times (Schildgen et al. 2013; Yıldırım et al. 2013; Çiner et al. 2015b) and distinctive physical characteristics of successive ignimbrite layers. The dissection of the plateaus often started from cooling fractures and ended in fairy chimney formations. When soft layers, such as lacustrine deposits and/or air-fall deposits, are occasionally present between more resistant ignimbrite flows, the chimney's caps are formed in the harder ignimbrite layer overlaying any softer formation. During a limited time span, the caps protect the fairy chimneys from erosion, giving rise to the development of extensive mushroom-like morphology. When the hard cap falls down or is eroded away, a sharp-pointed chimney is formed, and eventually the remaining cone is quickly destroyed by ongoing erosion. In the frame of similar processes, several types of fairy chimneys are formed depending on the nature of the ignimbrites (Figs. 31.6 and 31.7).

31.4.2 Effect of Climate

The climate (amount and intensity of precipitation, freeze–thaw cycles, drought and winds) also plays an important role in the development of the fairy chimneys. Today, hot and dry summers, and cold and wet winters characterize climate in Cappadocia. At Nevşehir (1260 m above sea level), average summer temperature is 19 °C and average winter temperature is 0 °C. Except in valleys where tree gardens are widespread, the region is poorly vegetated and hence the rainfall and snowmelt accentuate the erosion, especially in the softest volcanic units.

The Quaternary Period (2.58 Ma) is typically defined by the cyclic growth and decay of continental ice sheets and the associated climate and environmental changes (Denton et al. 2010). Even though these cycles are known to affect the formation and erosion of landforms, quantitative data from Anatolia are mostly concentrated on the Last Glacial Maximum (LGM) ($\sim$20 ka ago) and onwards (for Cappadocia see Roberts et al. 2001, 2016, 2017; Woldring and Bottema 2003; Bayarı et al. 2003; Berger et al. 2016; Çiner and Sarıkaya 2017; Jones et al. 2007; Sarıkaya et al. 2009, 2011; Sarıkaya and Çiner 2015, 2017; Dean et al. 2015; Zreda et al. 2011; Ulusoy et al. 2014; Oliva et al. 2018). Data from Anatolia, therefore, indicate that the climate since the LGM has been characterized by a general increase in temperature and precipitation at the onset of the Holocene ($\sim$11.5 ka ago). After the mid-Holocene, precipitation decreased as it did in all regions of central Anatolia. According to data obtained by Sarıkaya et al. (2009) in Erciyes Volcano, the climate during the LGM was 8–11 °C cooler than today, while precipitation values were similar to modern ones. During the Late Glacial period (~ 14–12.5 ka ago) climate was by 4 °C cooler and up to 50% wetter. During the early Holocene it warmed to 2–5 °C cooler and up to twice as wet as today, while the late Holocene was 2–3 °C cooler with precipitation amounts similar to those of today (Sarıkaya et al. 2009).

The precipitation and temperature contrasts from the LGM onwards, together with changes in densities/types of vegetation cover, probably generated differences in the intensity of erosion of the Cappadocian chimneys. Furthermore, it is most probable that this erosion may have increased greatly during the rather short-transition phases between these contrasting periods. It is well known that instability generated by the tectonic uplift of the plateau together with vegetation and soil degradation (whether due to climate or land use or cultural practices) favours erosion processes in areas sensitive to differential erosion.

31.4.3 Erosion Rates Obtained from Cosmogenic Nuclides

Although erosion controls the formation of fairy chimneys, it also has a destructive effect, which eventually threatens their future existence (Çiner et al. 2013). In addition to natural processes, anthropogenic effects induced by increasing touristic influence on vegetation, land-use and frequent stepping around the landforms play an increasingly important role in their progressive or sudden disappearance. To better understand the processes forming the fairy chimneys and appreciate their vulnerability, Sarıkaya et al. (2015) conducted a study for quantifying the rates of their erosion. To achieve this aim, they used in situ-produced cosmogenic isotopes for the first time in the Cappadocian landscape and obtained quantifiable long-term erosion rates for fairy chimney development stages. Their results show that the apparent ages of samples (i.e., of the start of incision which will lead to the chimney carving) vary between 148.4 ± 8.0 and 26.7 ± 2.8 ka while the plateau surfaces are eroded at a low averaged ablation rate of 0.6–0.9 cm/ka. The average incision rate increases to 2.3–3.3 cm/ka when the landscape is dissected to form fairy chimneys. The caps of chimneys have average incision rates of ~ 3.1 cm/ka. Once the chimney caps disappear and softer rocks below are exposed, average erosion rates increase significantly, by an order of magnitude or more.

Additionally, the erosion/incision patterns of volcanic rocks provide excellent markers for dating phases of landscape evolution. Cappadocia is formed mostly by horizontally emplaced Neogene-Quaternary ignimbrites intercalated with lava flows and epiclastic continental sediments that have been uplifted to ~ 1–1.5 km above the sea level since late Miocene (Schildgen et al. 2012). According to Aydar et al. (2013), morphological/palaeoaltimetric features constrained by radiometrically dated volcanic units indicate that there was neither major erosion nor incision between 10 and 5 Ma. According to these studies, the morphology, uplift rate, and incision rates of the CAVP reveal that the onset of uplift is posted 8 Ma and that major incision started after 5 Ma. Between 5 and 2.5 Ma, the incision rate is computed as 0.12 mm/year, whereas, in the last 2.5 Ma, the average incision rate slowed down to 0.04 mm/year. Furthermore, studies by Doğan (2011) and Çiner et al. (2015b) on the Kızılırmak River terraces also indicate an average incision rate, equated to surface uplift, of ~ 0.06 mm/year since ~ 2 Ma. Using the base of a basalt fill above the modern course of the Kızılırmak, to the west of Avanos village, Çiner et al. (2015b) also calculated a similar mean incision and hence rock uplift rate (0.05–0.06 mm/year) for the last 2 Ma.

31.5 Human Interaction

The name "Cappadocia" probably comes from Persian "Katpatuka" meaning "Land of Beautiful Horses". Alternatively, the name might have been derived from Cappadoxe River (present Delice River), which is a tributary of the Kızılırmak River, described in Geographika of Strabon. The earliest large village (sedentary settlement) in Anatolia outside the Fertile Crescent was founded by Pre-Pottery Neolithic populations about 10.500 years ago at Aşıklı Höyük near the village of Kızılkaya, in western Cappadocia. During the following millennia, all Anatolian civilizations present in various sites dispatched over the plateau, its valleys and its margins including Hittites, Assyrians, Mongols, Persians, Arabs, Armenians, Greeks, Romans and Turkic tribes from Central Asia, Selchukids, Ottomans and modern Turks. According to historic conditions and cultural needs, each civilization took advantage of the soft character of the ignimbrites for carving numerous troglodytic habitations such as houses, barns, pigeon houses, wine caves and hospitals within the ignimbrites.

31.5.1 Underground Cities

Since Antiquity, several periods of military instability caused the carving of so-called underground cities to serve as protection refuges capable of hosting large populations hiding below the ground surface. These "cities" are

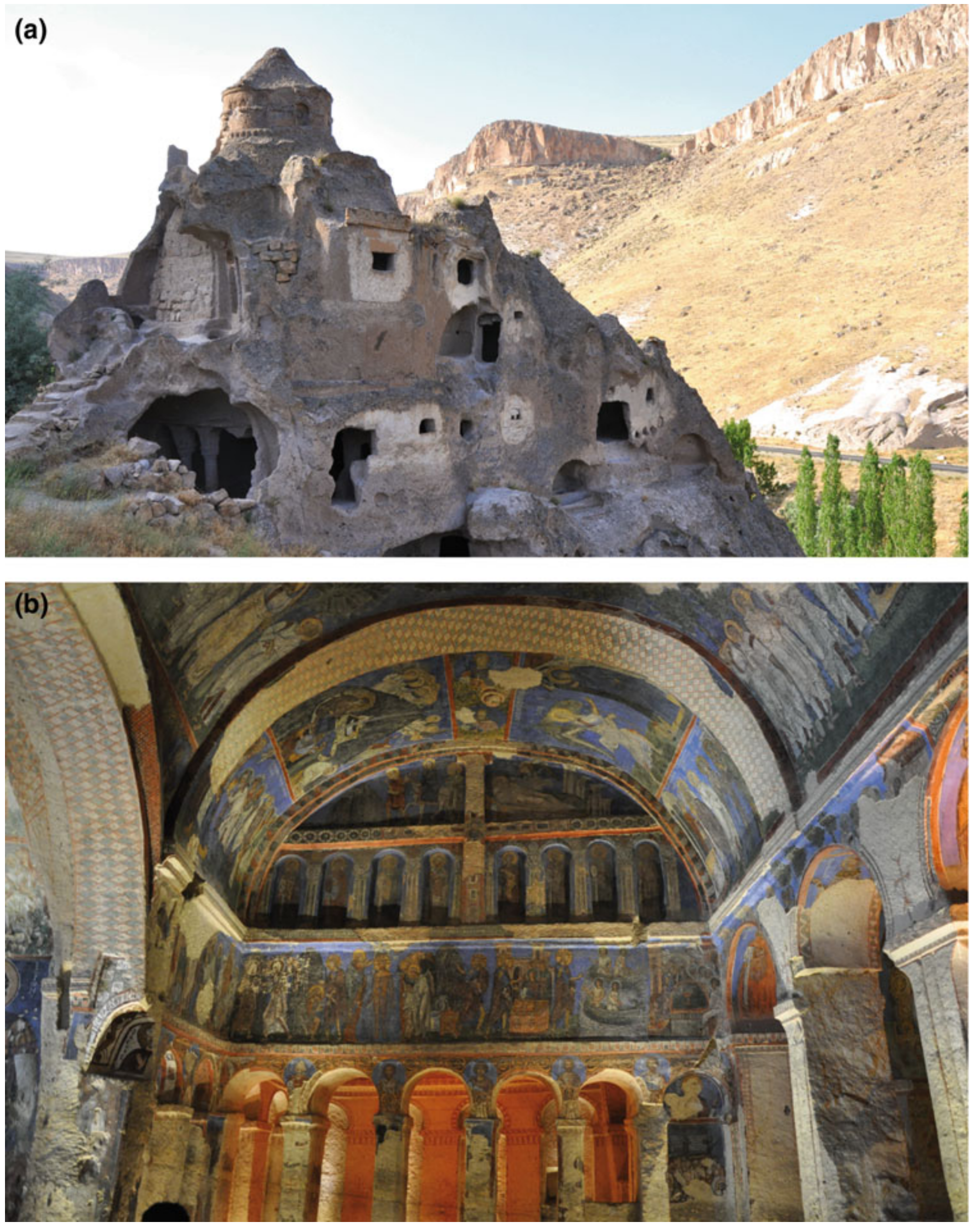


Fig. 31.8 **a** There are hundreds of troglodyte churches in Cappadocia. Kubbeli Church in Soğanlı Valley. Indurated Kızılkaya Ignimbrite in the foreground. **b** Paintings within the "Buckle Church" (ninth century) in Göreme Open Air Museum. Photographs by A. Çiner

composed of several levels of underground dwellings making Cappadocia as one of the world's largest cave dwelling complexes. Even though underground cities exist below many villages of Cappadocia, the most well-known ones are located at Kaymaklı and Derinkuyu villages. The largest underground city is in Derinkuyu and has a depth of approximately 55 m accommodating 6 floors. The entrances to these underground cities were discrete. Cleverly designed subterranean systems with rooms and connecting tunnels, air and waste shafts, wells, chapels and even kitchens were carved to accommodate several thousands of people in case of enemy invasions.

31.5.2 Troglodyte Churches and Monasteries

In the first centuries of Christianity, Cappadocia attracted many hermits who lived apart in solitary troglodyte hermitages. In the Christian era, numerous monastic communities with their own churches existed in the region (Fig. 31.8a). These communities were already well established in the iconoclast era (725–842 AD), as observed from paintings in several sanctuaries where the decoration is held to a strict minimum of symbols, mainly composed of sculpted or tempera painted crosses. After 842 AD, many rupestral churches, with richly decorated and brightly coloured painting were

Fig. 31.9 Pigeon houses carved within Kavak Ignimbrites. Different figures painted in various colours underlining each entrance of pigeon nest hole allow their easy recognition by pigeons and owners. Photograph by A. Çiner

carved in Cappadocia. Among the best-preserved monasteries in Cappadocia is the Eskigümüş Monastery in Niğde. The main church is spacious and its well-preserved frescoes are considered to be the best example of Byzantine art in Cappadocia. The "Open Air Museum" and the "Buckle Church" (ninth century) in Göreme village are also perfect examples of this cultural heritage (Fig. 31.8b).

31.5.3 Pigeon Houses

Local people used pigeons as a source of fertilizer for centuries. Several valleys in Cappadocia are well known for thousands of pigeon houses that have been carved into the abandoned caves and walls of collapsed churches, using different outside paintings for easy recognition (Fig. 31.9). Although the advent of chemical fertilizers reduced the use of pigeon fertilizer for decades, some farmers still maintain this tradition.

31.5.4 Troglodytic Hotels and Tourism

With the development of tourism in the area in the early 1970s the inhabitants first rented their troglodytic houses. As the demand grew, troglodytic hotels also grew in number (Fig. 31.10). Contrary to what is unfortunately seen in other touristic regions of Turkey, Cappadocia is relatively well preserved thanks to the strict rules on restorations. Many hotels with unique architectural character often result from old buildings or caves restored by the few people who really appreciate the region not for what it can bring financially but as a way of life. Today this trend is changing with the arrival of new "five-star" hotels into the market. The development of tourism industry is expected to grow here as in the rest of the country in the coming years and it seems that only a change in the mentality for a sustainable use of the troglodytic habitations can save this unique area.

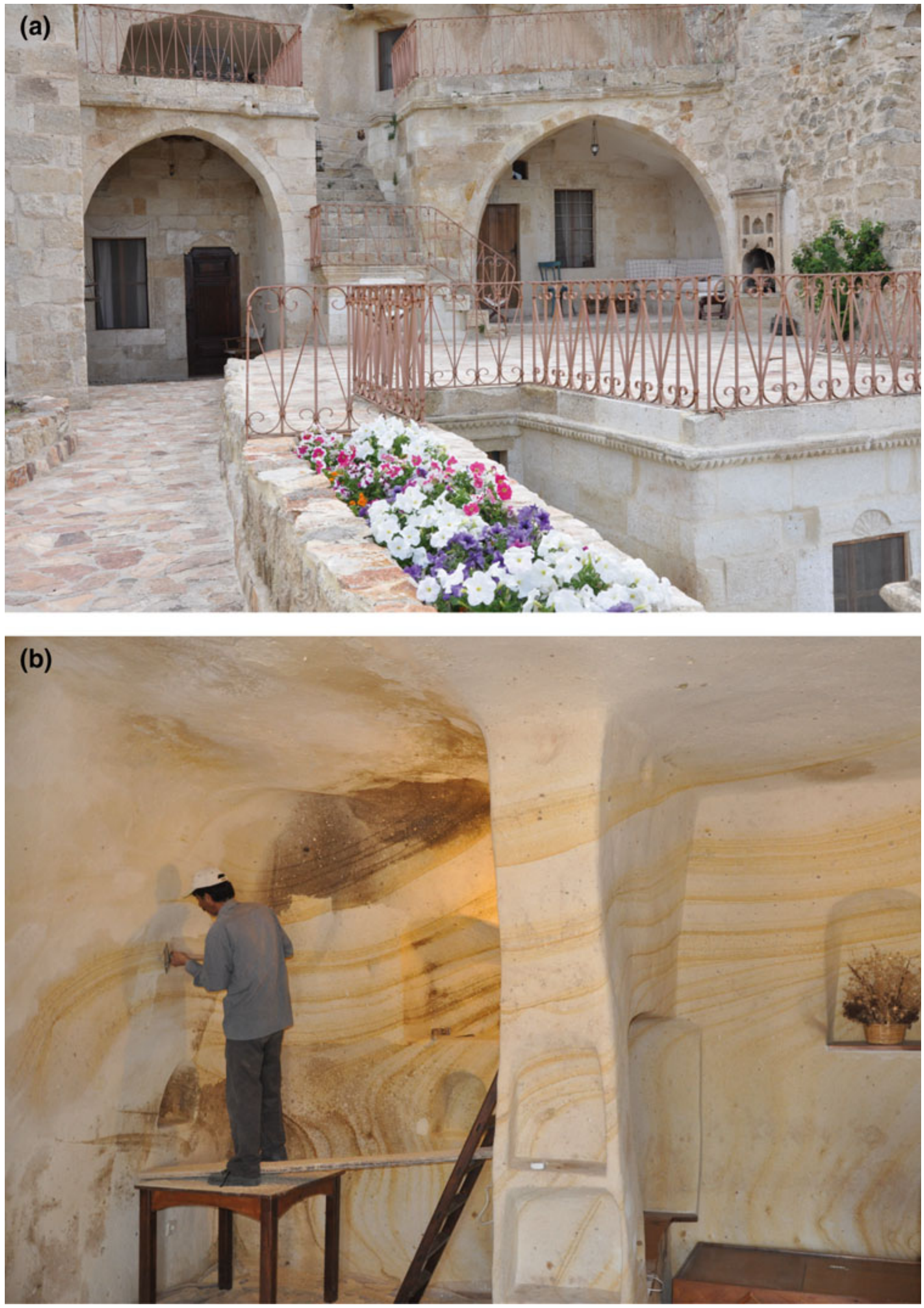


Fig. 31.10 **a** A troglodyte hotel (Kayadam Cave House) in Ürgüp. **b** Restoration of a cave room carved into the soft Kavak Ignimbrite. Photographs by A. Çiner

31.6 Conclusions

Cappadocia constitutes a spectacular example of the effects of differential erosion of ignimbrites by wind, water and gravity. The resulting landscape is a mixture of flat-topped mesas, smoothly weathered surfaces, valleys and gorges and different types of fairy chimneys. Together with their historical setting, rock-hewn churches and troglodytic houses a mix of cultural and natural landscapes formed in harmony with their surroundings. Negative impacts of the growing pressure from contemporary tourism threaten this unique UNESCO World Heritage landscape, which can only be preserved by sustainable use that is still to be defined and implemented.

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