ST. FRANCIS AND GIOTTO: THE SAINT AND THE ARTIST WHO STARTED THE ECOLOGICAL MOVEMENT

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Abstract. From Antiquity to the Middle Ages, man had a conflictual relationship with nature, seeing it as representing either divine or satanic forces. On the vanguard of a change in perspective toward the natural world was St. Francis of Assisi (c.1181-1226) who is now, thanks to his pioneering work, patron of ecology. He set forth the revolutionary philosophy that the Earth and all living creatures should be respected as creations of the Almighty.

St. Francis' affinity for the environment influenced the artist Giotto (c.1270-1337) who revolutionized art history by including natural elements in his religious works. In this manner, Giotto portrayed sacred images on Earth, separating them definitively from their abstract, unapproachable representation in Byzantine art. Giotto's works are distinctive because they portray daily life as blessed, thus demonstrating that the difference between the sacred and profane is minimal.

Disseminating the new ideas of St. Francis visually was very effective, as the general populace was illiterate. Seeing frescoes reflecting their everyday lives in landscapes that were familiar, changed their way of thinking. The trees, plants, animals and rocky landscapes were suddenly perceived as gifts from the Creator to be used, enjoyed and respected. Further, Giotto recognized that the variety of dramatic landscapes would provide spectacular visual interest in the works. The Umbria/Lazio/Tuscany regions of central Italy, where the Franciscan monasteries were located, are seismically active, geologically complex mountainous areas with faults, upthrusts, nappes and diverse lithologic deposits. By including the striking landforms, and portraying them accurately, Giotto allows us the opportunity to identify the types of rock in his frescoes and possibly even the exact location he depicted.

1 Introduction

For a number of years, an international group of scientists and artists have been exploring the many connections between Earth Science and Art. As a geologist, I have long appreciated an artists' ability to capture the beauty of the Earth in a painting, poem or sculpture. While I can analyze the rock formations and marvel at the mystery of the Earth's topography, it takes an artist to move me to tears by presenting their unique view of the landscape. In doing so, an artist presents the Earth using the visual—a tool so powerful it can move the most naïve viewer to experience the divine nature of the Earth.

My fascination with St. Francis developed because of his revolutionary ideas regarding ecology, but I soon learned that without the illustration of his ideas in frescoes by Giotto, he might not have had such a powerful and lasting impact. The analysis of Giotto's frescoes from a geological standpoint was a challenge, as St. Francis' monasteries were located in Lazio, Tuscany and Umbria, regions in central Italy that have some of the most complex and still unexplained geology in the world. Yet, it was precisely this geology that made Giotto's frescoes full of geomorphological wonder. He integrated his figures into this dramatically disordered landscape forming a compelling composition for any viewer. These landscapes have survived 700 years, allowing modern geologists the opportunity to study them and compare them to current geological maps.

In order to appreciate the revolutionary ideas of St. Francis and Giotto, a background on the medieval ideas pertaining to nature will be discussed. A select number of frescoes will be analyzed geologically, with attendant historical information explaining the scene. Geologic maps can be found in the appendix which can be used as references for the cited locations.

1.1 The Idea of Nature in the Middle Ages

In the Middle Ages, the practice of linking natural phenomena to divine or satanic forces was the norm. Since nature's behavior could not be predicted or controlled, medieval man lived in a constant state of awareness of its capriciousness. In order to alleviate stress, a method of spiritual interpretation called "anagoge" was devised to explain natural occurrences. This meant that one had to search for the of meaning God's messages in nature through the complex and oftentimes arbitrary symbolism He chose to use. It was thought that by deciphering and diffusing malefic symbols one could avoid disaster or, in the case of auspicious portents, obtain a fortuitous outcome. The search for meaning in nature was much more important than the search for "how nature works" as mechanisms were not valued. After all, God was in charge of everything and what he was doing "behind the scenes" didn't matter. As a result, men tried to become more empathetic and more closely aligned to nature to understand God.

1.2 St. Francis

In the early 1200's, a young man from Assisi named Giovanni di Pietro di Bernardone, but known to us as Francis, gained a following for his revolutionary ideas pertaining to a sympathetic view of nature. Francis lived in Umbria, a region of Italy which today is still green, fertile and infused with a palpable spirituality. He was born into a well-to-do family of cloth merchants. As a young man, he renounced his own material wealth, even taking the position that the Church do the same. He walked to towns and villages, espousing a simple way of life and encouraging a reverential attitude toward the natural world, for he believed that nature was the mirror of God. He called all creatures his "brothers and sisters" and preached that people had a duty to protect and enjoy nature as the stewards of God's creation. He constructed a series of monasteries which were one day's walk away from each other, situated in forests or snuggled up against the sides of mountains (Fig 1). His own cell and bed were carved out of rock. Francis was also a poet and an

93 outstanding innovator in the history of Italian literature. In his *Canticle of the Sun,* believed
94 to be the first work written in the Italian language, he praised God for creating "Brother Sun"
95 and "Sister Moon".
96
97 Soon he attracted a group of followers which were organized into many religious orders
98 for both men and women. He became so influential that the Pope had to acknowledge
99 him and allow his orders (Order of Friars Minor, the women's Order of Saint Clare, the
100 Third Order of Saint Francis and the Custody of the Holy Land) to be officially recognized
101 by the Church. Francis was so venerated that Pope Gregory IX canonized him in 1228,
102 only two years after his death and ordered a basilica be constructed in Assisi. It was built
103 with indigenous pink Subasio limestone (Fig. 2) and completed in 1253. The interior was
104 covered with frescoes painted by several generations of Italian artists. This one building
105 was the most fruitful single training school and meeting place in the history of Western
106 art.
107

1.3 Giotto

109 Among the many artists who worked in the Assisi basilica were such famous names as
110 Cimabue (1240-1302), Duccio (c.1255-1319) and Giotto (1267-1337). They sought to
111 honor St. Francis by portraying his life in a series of frescoes which not only served a
112 proselytizing function but changed the history of art.

113 Giotto's works were so revolutionary that today he is considered the founder of
114 Renaissance art. But the seeds of this dramatic stylistic transformation were planted by
115 Cimabue, who worked at Assisi during the Pontificate (1288-1292) of Nicolas IV, the first
116 Franciscan Pope. Cimabue broke from the rigidness of Byzantine art where figures were
117 rendered flat and one dimensional. Instead, he made them more realistic by using
118 proportions and shading for volume.

119 Giotto followed Cimabue's lead in changing the flat figures of the Byzantine art form,
120 conducive to contemplation, to a more relaxed style by showing man in a natural setting.
121 He observed the landscape and sought to portray its beauty and order. He used painting
122 techniques to depict figures more solidly, so that they would appear three dimensional
123 and thus, created the illusion that they were moving through a landscape within the
124 picture. Giotto integrated sacred images into the Earthly landscape, separating them
125 definitively from their abstract representation in Byzantine art. By portraying daily life, the
126 realm of the sacred appears to be diminished, but that of the profane acquires a grand
127 dignity and seriousness, which became Giotto's distinctive characteristic.
128
129 Another revolutionary aspect to this new type of painting was that both Duccio, (a
130 contemporary of Giotto's), and Giotto were among the first to add a depth perspective to
131 the paintings. Interest in perspective had been lost in the preceding centuries. Duccio
132 used modeling (playing with light and dark colors) to reveal the physique beneath the
133 clothing's heavy drapery. Hands, faces and feet became more rounded and three
134 dimensional, giving his figures vitality. Giotto used various techniques, such as presenting
135 his buildings obliquely to take up more space in depth, and presenting his figures with
136 volume, scale and perspective to evoke realism. The two artists also placed their figures

137 within natural settings paying special attention to plants, trees, animals and making
138 detailed rock formations an integral part of the scene. As a result, their figures interacted
139 with one another, creating a sense of fluidity and movement in a realistic landscape, which
140 was astounding to the medieval viewer.

142 The inclusion of natural elements in visual art as a method of disseminating the new ideas
143 of St. Francis was very effective, as the general populace was illiterate. Seeing frescoes
144 reflecting their everyday lives in familiar landscapes changed their way of thinking. The
145 trees, plants, animals and rocky land forms which had never been valued suddenly
146 became part of the incredible universe that God had created. The Earth, and all things
147 living upon its glorious terrain were gifts from the Creator to be used, enjoyed and
148 respected. Duccio and Giotto used nature as a symbol, as the stage on which the mystery
149 of life, both spiritual and temporal was played out. A lake, a mountain range, a valley,
150 depicted in a realistic manner would make the viewer identify with the painting. With
151 enough detail, the viewer could find any number of things that reminded him of his village,
152 farm or pasture. His journey of discovery would make him not only feel a kinship with the
153 work, but also a sense of conviction that the work was real. The authenticity of the
154 landscape contributed to disseminating the gospel by convincing the viewer that the
155 sacred message contained therein was valid, be it Christ's birth or crucifixion or an
156 episode in the life of a saint. And so, the depiction of these sacred scenes acted as a
157 catalyst for changes in Western piety as well as Western art.

158 Considering how venerated Francis was, one would think that Giotto would portray him
159 as a sacred figure surrounded by elegant surroundings, or embellished churches worthy
160 of exalted adoration. But Giotto could not do this because of the way Francis lived. The
161 stories and legends pertaining to his life and the humble places which he inhabited
162 required Giotto to place him in nature to depict his life accurately. So, we see in Giotto's
163 works the visual story of the ecological movement started by Francis.

164 In looking at the geology of Umbria, Lazio and Tuscany, in central Italy, which Giotto
165 portrayed in the scenes of the life of St. Francis, we can see that he had a keen eye for
166 geologic formations and took the time to portray them realistically. These regions have
167 some of the most complex geology in the world, for the Apennine Mountains are not only
168 seismically active but are being contorted by forces of both compression and extension.
169 There are faults, upthrusts and nappes in the area, all of which displace strata, making it
170 difficult for geologists to interpret the regional geology. Yet in Giotto's works we see that
171 he found these unique geologic formations perfect for providing visual interest, yet
172 accurate enough for geologists to identify the rock types and even exact locations
173 represented in the scenes. To better understand the placement of the Franciscan
174 monasteries and Giotto's portrayal of the landscape refer to the geologic maps at the end
175 of the article.

176 **1.4 St. Francis Preaching to the Birds**

177 In Byzantine art, the background was usually gold, a glorious, expensive color which
178 invoked a sense of awe of the Divine and, as a result, kept the viewer at a reverential
179 distance. As a color, it was flat which did not draw the viewer into the scene. Giotto's
180 treatment of this event is very interesting because of his use of a gold background. The
181 gold finish is textured and shaded and the dark foreground cuts a horizontal band,
182 imparting depth and three dimensionality. He then places the tree in a manner in which it
183 is growing out of the picture. St. Francis is preaching to birds who are walking and flying
184 toward him, seemingly enraptured by his words. Due to the use of color, shading and
185 perspective, Giotto created a work that had volume and movement. The tree is swaying
186 in the wind, the birds are flying and walking and the friar behind St. Francis is in a different
187 plane, giving the whole picture a sense of depth and dynamism. The warm colors invoke
188 an autumn day with an orange-gold sun illuminating the background. While the use of
189 earth tones and touches of dark gray-greens give the work a cohesiveness, warmth and
190 intimacy. One wants to watch, an experience we have all had while viewing flocks of birds,
191 yet we want to be still and quiet so as to not disturb them lest they fly away. In this manner,
192 Giotto works his magic, allowing us to feel the peace and mystical nature of God's Earth
193 and His creations by presenting them in a simple setting that is reminiscent of our
194 everyday life.

195 An incident illustrating Francis' benevolent attitude towards nature is recounted in the
196 *Fioretti di San Francesco* (The Little Flowers of St. Francis), a collection of legends and
197 folklore that was compiled after his death. One day, while Francis was traveling with some
198 companions, they happened upon a place in the road where birds filled the trees. He told
199 his companions to "wait for me while I go to preach to my sisters the birds." The birds
200 surrounded him, intrigued by the power of his voice, and not one of them flew away.

201

202 1.5 Geology

203 As to the lithologic commentary on the art works, here are the types of deposits which
204 can be seen aboveground in the referenced areas: travertine, conglomerates, sands, silts,
205 dolomite, limestone, fluvio-lacustrine deposits, turbidites, carbonates, calcareous tufa,
206 evaporates, anhydrites, dolostones, marls, sandstone, (basement crystalline and volcanic
207 rocks which cannot be seen, have been left out). The oldest above ground deposits date
208 to the Triassic.

209 Comments on the strata will be categorized based on color, form and congruity with the
210 known geologic conditions in the area since the exact lithology in a Giotto work cannot be
211 determined with certainty.

212 For scenes depicting events in the region of the Holy Land, the rocks Giotto portrays are
213 devoid of vegetation reflective of the desert environment, all the while showing bedding
214 planes, erosional features and other realistic detail.

The following works by Giotto are a small sampling of his extraordinary output. They were chosen because of his inclusion of geologic formations and natural elements.

1.6 Nativity

Francis staged the first living Nativity scene or *presepe* on Christmas in 1223 in a limestone grotto at his monastery at Greccio (Fig. 4). Interestingly, Francis had to obtain papal permission to use an ox and and ass in the manger scene to avoid the charge of novelty. Once approved, he invited the local townspeople, along with their animals, to participate in a recreation of the holy event. He situated the participants, including livestock, in the grotto and then placed a newborn in a manger cushioned with hay. After, Francis stepped forward and lead a celebratory mass. The altar was a block of limestone, still visible today. This brought the message of Jesus' birth down to Earth so that the lowliest person could identify with the humble manner in which He was born.

If we look at a Byzantine representation of the Nativity (first part of the 14th c. (Fig. 5)) we can see Jesus' birth depicted in a cavern in a landscape complete with rocks, mountains and trees. The Byzantine style, lacking perspective and scale, portrayed the figures and landscape elements one-dimensionally, configured in a single plane. In religious art, this effectively created a psychological distance between the sacred events and the viewer, evoking a reverential experience.

Giotto revolutionized art by taking Byzantine iconography and humanizing it. Following Francis' lead, the Nativity thus became a natural event. Using elementary perspective techniques, he was able to compose a sacred scene that appeared similar to a person's daily life. In this way, the viewer had a direct experience with the miraculous, allowing him to internalize the supernatural event and ultimately transfigure his human consciousness into a vessel for the divine.

Giotto also revolutionized the depiction of natural elements by including them as vital to the composition, and also applying the same techniques-- perspective, shading, etc. on them as he used on his figures. This rendered the scene realistic and the location was often identifiable to the locals. In his portrayal of the Nativity he reproduced the geology of the area surrounding the monastery at Greccio (Fig. 6) which consists of carbonate units of the Sabina Sequence (Meso-Cenozoic).

He depicted a limestone ledge and added a rudimentary wooden roof for shelter. The limestone strata in the background are upthrust as shown by the vertical relief. These blocks, formed by the violent movement of the earth, now act as a sheltering backdrop for the manger holding the newborn. Angels also hover overhead to protect, pray and rejoice at the miraculous event. The ox and donkey on the left are farm animals, vital to the sustenance of the people. The sheep, goats and their shepherds were also common to the area. Today, going to the monastery at Greccio, (Figs. 7,8) one can see the limestone cliffs, crevasses as well as the original grotto that inspired St. Francis.

253 In describing the Nativity, we are told that Mary and Joseph embarked on a journey, the
254 night was cold and starry, there was no room in an inn nor help with the birth. The lowly
255 manger was filled with hay and animals were settling in for the night. Here, we see that
256 Giotto continues the theme of Jesus' birth in a limestone landscape (Fig. 9). The upthrust
257 block in the background provides shelter for the newborn set upon an altar-like formation
258 of the bedrock in the foreground. And so, Jesus was born without fanfare as people went
259 about their daily tasks. He did not stop the world, rather He changed its orientation and
260 sensibility. Men continued to eat, talk and work, live and die, yet the birth of Jesus changed
261 the intrinsic purpose of their actions and their lives. Placing Jesus in a manger, the locus
262 where animals were fed, let us know that He would provide us with food as well (his body).
263 The gospel of St. John 1:9 tells us: there came into the world the true light (external light)
264 which illuminates every man. Meaning that with the birth of Jesus, divine light appeared
265 on Earth and was the vehicle used to communicate the gift of divine life. In the story of
266 Creation, the contrast between darkness and light was used as a metaphor. Now, in the
267 mystery of the Nativity it returned, and was transfigured into a more intimate form (might
268 be considered internal light) where God enters into the lives of men to create a second
269 definitive creation. John 8:12 says "I am the light of the world, he who follows me does
270 not walk in darkness but will have the light of his life." Giotto deftly incorporated light into
271 his scenes to illustrate gospel teachings as well as well as miraculous events.

272 Another revolution in the portrayal of the Nativity was the change, in the 14th century, from
273 the use of a cavern, to a "inn" (*kataluma*) as described in the Gospel of Luke. From that,
274 the location was often a "diversorium" which might be an inn, a cabin (*capanna)*, or a hut
275 with a canopy (*tettoia*) which were common in medieval cities. These were public places
276 where people came to rest and talk. These became the new churches, humble and
277 unpretentious, according to the reform principles of the Franciscans who longed to return
278 to a simple evangelization.

279 In this fresco, we pass from a desert, an isolated locale, to an urban setting (Fig. 10). The
280 abandonment of the desert and the grotto has a precise theological justification. By
281 placing Jesus' birth in a city, not in the wilderness, the mystery of his divine nature would
282 not be hidden from the people. He is portrayed as being born in a town, near a market,
283 in an open, populated place where his nature can be seen by all.

284 The baby is often placed in the foreground on the earth, underlining his human character,
285 propped on a bale of hay-- an illusion to the eucharistic bread, or on a sheet--evocative
286 of the shroud. In this manner, if the faithful looked down, they would have understood
287 the humility of the divine birth. From an etymological standpoint, the word "humble" can
288 be taken to mean "attached/close to the ground" (in Latin, *humus).*

1.7 The Flight into Egypt

290 The Gospel of Matthew 2:13-23 recounts that after the visit of the Magi to the newborn
291 child, an angel appeared to Joseph in a dream and told him to flee to Egypt with Mary
292 and Jesus, as King Herod would seek to kill the child. In this scene, Giotto portrays an

293 arid landscape (Fig. 11). The mountains are sparsely vegetated and the desert through
294 which they are traveling is inhospitable. It is an arduous journey with the donkey making
295 its way along a narrow path with a steep precipice in the foreground. Joseph leads the
296 way with an angel, most likely the one which appeared to him in the dream, guiding and
297 protecting them on their way. Mary and the child sit upright, with great dignity as they
298 endure the harsh traveling conditions. Giotto chooses a background of gray and blue to
299 impart the sensation of a rocky, barren landscape where even the few trees must struggle
300 to survive. He pays attention to the rock strata and bedding planes so that the formations
301 would appear close to those we see in nature. The dark blue sky and impending darkness
302 causes a sense of preoccupation for the welfare of the family. Were they traveling by
303 night to avoid detection or avoid the harsh sun? This is a mystery. Where will they rest?
304 There are no buildings or indications they are close to a village or city. So here, Giotto
305 presents a barren, dark, uninviting environment that would have been unfamiliar to the
306 Italians living in the florid Italian countryside. Yet, they would understand the hardship
307 involved for a mother and newborn to undertake this journey on a donkey. The vast
308 unknown terrain, with no water or vegetation to sustain them, leaves the viewer
309 sympathizing with the Holy Family and respecting the sacrifice they made for our ultimate
310 salvation.

1.8 The Dream of Joachim

312 This touching scene shows St. Joachim, husband of St. Ann and father of the Blessed
313 Virgin Mary, in exile in the wilderness (Fig. 12). The landscape, colors, and posture of St.
314 Joachim convey a profound sense of despair. St. Joachim and St. Ann had reached
315 advanced ages without having a child. This was considered an indication of God's wrath.
316 Joachim went to the temple to make a sacrifice, which was rejected, and he was then
317 expelled by the rabbis. He went into exile in the mountains leaving behind his wife, Ann.
318 As we can see, Giotto places him in a hunched-over position with his head resting on his
319 knees. He is desperate, inconsolable. He sits directly on the ground, is he so weak or
320 defeated that he no longer can or will get up? The landscape is stark and a dark mountain
321 with no vegetation rises menacingly in the background. The carbonate rocks in the fore
322 and middle ground are lighter, reflecting their natural color, but arid, save for a very few
323 trees. The only people in view are the shepherds who frequented the mountains with their
324 flocks. The small cabin is made of blocks of limestone likely mined from the local area.
325 Perhaps it was the "*refugio*" or cabin of the shepherd who used it at night. One of the
326 sheep appears to be entering a grike (solution fissure). Giotto portrays the natural
327 landscape here as barren, a metaphor for the fruitless matrimony of Joachim and Ann.
328 He does a marvelous job depicting the nearly vertical bedding planes of the dark brown
329 formation, perhaps a bedded sandstone, in the distant background. Geologically, the
330 beds were originally laid down flat, and with subsequent deformation and movement they
331 were thrust upward into their nearly vertical configuration. Giotto depicts the carbonates
332 in the foreground as they appear in nature, blocky, with cracks and crevasses and, where
333 it has been eroded by wind or rain, has softer edges. Giotto creates a masterful geologic
334 environment, paying careful attention to the physical characteristics of the different types

335 of rock. What hope can there be in such an environment where there is no sign of fertility,
336 no lush green plants, no water—nothing. There is something however, the angel. It is
337 bringing word to Joachim that Ann is with child and she will be blessed. Joachim's world
338 will change with this message and our world will be changed as well.

1.9 St. Francis Receiving the Stigmata

340 The grotto of the monastery at La Verna was the place at which St. Francis received the
341 stigmata of Christ in 1224. La Verna, where today, pilgrims still visit to pray and meditate
342 is located on Mt. Penna in the Apennine ridge connecting Casentino and Valtiberina. In
343 ancient times, people couldn't explain how this mount, a mass of limestone, came to be,
344 so the legend was born that it (Mount Alvernia in Latin), geographically known as Mt.
345 Penna was created by a strong earthquake occurring when Jesus died on the cross. Its
346 geological origins are so complex that even today, scholars are still trying to decipher it.
347 However, the latest research indicates that Mt. Penna (Fig. 13) is composed of Miocene
348 calcarenite resting Cretaceous successions belonging to the eastern Ligurian Units
349 (Sillano Formation, Early Cretaceous).

351 In this image of solitary mystical experience (Fig. 14), Giotto portrays Francis on a block
352 of limestone which has been weathered and uplifted as seen by its nearly vertical relief.
353 A cleft in the side of the cliff, common to calcareous deposits, has opened. Giotto uses
354 this rock, which has been sliced open, to imitate the wounds in St. Francis' hands and
355 feet. The church in the foreground is made of the gray limestone found in the area and
356 commonly used for construction. To the left of the church grikes (solution fissures) and
357 clints (limestone separated from adjacent sections by solution fissures) are starting to
358 form. Behind the kneeling figure is the cave where, in one account, he struggled nightly
359 with demons. Above the cave perches the falcon which woke him for his vigils, and whose
360 hovering flutter was an omen of the heights of contemplation to which Francis would soar.
361 Flora and fauna are sparse and the sky is a deep gray black forcing us to pay attention
362 to the miracle that is playing out on this mountainside. The Franciscans used this location
363 and divine occurrence to demonstrate that mountains were vital in the sacred ritual, thus
364 promulgating the idea that they would provide a nearness to God and a source of divine
365 inspiration.

367 An excerpt from the anthology "*Fioretti di San Francesco*" (The Little Flowers of St.
368 Francis), describes this miracle:

370 *"considering the form of the mountain and marveling at the*
371 *exceeding great clefts and caverns in the mighty rocks, he betook*
372 *himself to prayer and it was revealed to him that those clefts…*
373 *had been miraculously made at the hour of the Passion of Christ*
374 *when, according to the gospel, the rocks were rent asunder."*

1.10 St. Francis Gives His Mantle to a Poor Man

377 In this scene, Francis demonstrates his commitment to refuting worldly goods by giving
378 his mantle to a poor man (Fig 15). He has abandoned his fine clothing and is now dressed
379 in the simple sackcloth emblematic of the congregation of friars. This is an unwitnessed

380   and spontaneous act which takes place in a rural setting below Assisi. Francis is placed
381   at the midpoint, between two hills, one with a town and the other with a monastery. He
382   leaves one behind and moves unknowingly toward the other. Giotto uses perspective
383   and scale to depict the town realistically in the distance, complete with the walls which
384   surround it. Remnants of medieval walls such as these, constructed with local material,
385   often limestone, can still be seen today. The towns were historically located on high
386   ground for security. The finely detailed terrain upon which Assisi is built is evocative of
387   the countryside one can see today in Umbria, Tuscany and Lazio. The rock formations
388   are most likely limestone due to the color, blocky form, faults, grikes and clints. The gaping
389   gorges and crevices are still visible today. Enormous sections of strata were overturned
390   and displaced as a result of violent mountain building and continuous seismic activity in
391   the region.

392   It is said that Francis walked from one village to another, where he would preach. Giotto
393   places him on a solitary path out of town. In this way, out of sight of anyone, he practiced
394   his charity—anonymously and in the midst of nature. The colors Giotto uses are
395   characteristic of limestone, ranging from milky white to ivory to light gray and pink. The
396   towns would have been constructed with blocks of local calcareous rock so the delicate
397   pastels which characterize the buildings and walls are the actual color of the indigenous
398   rock. In fact, many of the buildings in Giotto's frescoes are pink. The trees hang
399   precariously on the slopes as they endeavor to insert their roots in crevasses and cracks.
400   The misty blue sky is common to the area, where frequent rainfall and clouds add to the
401   mystique of the atmosphere. A scene like this would resonate with any viewer as they
402   would understand the landscape and could recognize the local cities with their houses,
403   churches and towers. They could see familiar mountain paths and remember their own
404   difficult journeys, be them psychological, spiritual or corporeal. And so, through Francis'
405   example, and ultimately through their own actions, seen or unseen, they could become
406   saints as well.

407   **1.11 The Legend of St. Francis: Miracle of the Spring**

408   St. Francis, retiring to pray in the wilderness during high summer became ill and was
409   forced to go by donkey (Fig. 16). When the farmer who owned the animal begged for
410   water, Francis took pity on him and, after praying, struck a rock and water came bubbling
411   out of the earth. Here, Giotto portrays the landscape in the foreground and middle of the
412   picture as calcareous sinter terraces formed by the slow flow of calcium rich water. In the
413   background, large blocks have been displaced and turned upright. The textures bedding
414   planes and erosional patterns are realistic. In the foreground St. Francis prays on inclined
415   terraced calcareous sinter. In the foreground we see a crevasse which was formed during
416   the ongoing seismic activity in the area. In the background we see a dark area between
417   the two rock formations which may be a fault. Limestone is porous and often springs will
418   gush forth from the interior of the earth as shown in this picture (Fig. 17). The landscape
419   is consistent with the area near Assisi, Rieti and Greccio where St. Francis' monasteries
420   were located. The ground has been fractured and deformed and many faults have caused

421 displacement of strata as well as fissures and crevasses. The fact that Giotto chose to
422 portray the local landscape so accurately is not only a testament to his skill as an artist,
423 but also his appreciation of nature. In this way, he presents viewers with a scene that
424 evoked a sense of familiarity. Interestingly, the Italian Secretary of Transportation,
425 Riccardo Nencini, advanced a theory the actual location of this spring is the cascade of
426 the Rovigo torrent in Firenzuola.

427 **1.12 The Enduring Legacy of St. Francis and Giotto**

428 The frescoes, altar panels and paintings reflecting the new naturalistic style also provided
429 visual accompaniment to the popular preaching approach practiced by St. Francis-- not
430 in Latin, but in the spoken language (Umbrian form of Italian). Together, the visual and
431 the audible messages centered on the mystery of the Incarnation and on the need for
432 repentance. In fact, the power of the visual representation of nature was much more
433 powerful than the written word, as most people were illiterate and texts available for study
434 were for the most part, ancient or ecclesiastical. Aristotle, Pliny and others formed the
435 basis of natural philosophy and their ideas had not been altered or challenged in 1,500
436 years. With the arrival of St. Francis and Giotto however, a shift in thinking resulted in
437 massive changes in many disciplines, and nature was one of them. When texts on nature
438 started to be published in the Renaissance, the ideas they set forth were very late in
439 arriving, for the ecological ideas of St. Francis as represented artistically by Giotto had
440 already been absorbed into the psyche of the common man for over 200 years.

441 Some 750 years after the saint's death, on 29 November 1979, Pope John Paul II
442 declared Saint Francis the Patron Saint of Ecology. Successive Popes continued to use
443 St. Francis as a model in their public comments over the years:

444 "…not to behave like dissident predators where nature is concerned, but to assume
445 responsibility for it, taking all care so that everything stays healthy and integrated, so as
446 to offer a welcoming and friendly environment even to those who succeed us."

447 "As a friend of the poor who was loved by God's creatures, Saint Francis invited all of
448 creation – animals, plants, natural forces, even Brother Sun and Sister Moon – to give
449 honor and praise to the Lord. The poor man of Assisi gives us striking witness that when
450 we are at peace with God we are better able to devote ourselves to building up that peace
451 with all creation which is inseparable from peace among all peoples."

452 "It is my hope that the inspiration of Saint Francis will help us to keep ever alive a sense
453 of 'fraternity' with all those good and beautiful things which Almighty God has created."

454 "St. Francis teaches us that, the world of God and the world of nature are one."

455 **1.13 Conclusion**

456 The unlikely partnership of St. Francis and Giotto, two revolutionaries, changed Western
457 piety, art history and natural philosophy. Unbeknownst to them, their legacy would

458 ultimately provide a means of uniting art and religion with geology. By carefully placing
459 and configuring geological elements realistically in his frescoes, Giotto allows modern
460 geologists to analyze the geology while viewing the works. Not only can they identify the
461 landforms of central Italy, one of the most complicated areas in the world, they know that
462 Giotto's pastel colored buildings were not flights of fancy but duplicated the colors of the
463 indigenous pink, grey and ivory limestone actually used in medieval construction.
464 Researchers can marvel at the placement of Francis' monasteries on outcrops and
465 mountains which are geologic anomalies and learn that these outcrops were, and still are,
466 miraculously sacred sites. And so, Giotto's use of complex geological elements to tell the
467 story of St. Francis becomes, for geologists, a way of participating in and contributing to
468 the realm of art and religion.

469 **Appendix A**

470 Geological maps of Franciscan sites

471

472 **References**

473 Anonymous, I Fioretti di San Francesco Il Novellino, Rizzoli, Milano, 1979.

474 Brogi, A., Fabbrini, L. The Monte Penna thrust (southern Tuscany, Italy): Geometry and
475 kinematic of a collisional structure affecting the Tuscan Nappe during the Northern
476 Apennines orogenic building. Italian Journal of Geosciences 129(1) 74-90, February
477 2010.

478 Carrara, C., Ferreli, I., et al. International Geological Congress Field Trip: The Rieti
479 Intermountain Basin and S. Francesco d'Assisi c/o IGAG - CNR, Roma, Italy. Apat - Italian
480 agency for Environmental Protection and Technical Services, Roma, 2004.

481 Dall'Asta, Andrea, Nascere Il Natale nell'arte, Edizioni San Paolo, Milano, 2012.

482 Edgerton, Samuel Y., The Heritage of Giotto's Geometry Art and Science on the Eve of
483 the Scientific Revolution. Cornell University Press, Ithaca, 1993.

484 Falcetti s, Guerrieri l., et. al., Field trip guide to the Rieti Plain and the Rieti town.
485 Geological and hydrogeological aspects of a territory featured by historical and cultural
486 heritage. Mem. Descr. Carta Geol. d'It.102, pp. 73 – 86 fig. 15 Servizio Geologico
487 d'Italia-ISPRA Roma, 2014.

488 Fusarelli, Massimo ofm, Guide to the Sanctuaries of the Rieti Valley, B.N. Marconi,
489 1999.

490 Lena, G., Barchi, M.R., Alvarez, W, et. al., Mesostructural analysis of S-C fabrics in a
491 shallow shear zone of the Umbria–Marche Apennines (Central Italy), Geological
492 Society, London, Special Publications, 409, 149-166, 19 November 2014

493   Mancini, Marco, Cavinato, Gian Paolo, The Middle Valley of the Tiber River, Central
494   Italy: Plio-Pleistocene Fluvial and Coastal Sedimentation, Extensional Tectonics and
495   Volcanism. Fluvi Sedimentology VII, pp. 373-396. 2009.

496   Moleta, Vincent, From St. Francis to Giotto, Franciscan Herald Press, Chicago, 1983.

497   Panofsky, Erwin, Perspective as Symbolic Form, Zone Books, 1997.

498   Schama, Simon, Landscape and Memory, Knopf, New York, 1995.

499   Zeri, Federico, Giotto Compianto su Cristo morto, Rizzoli, Milano, 1993.

500

501   Fig. 1. Map showing Franciscan monastery locations (in yellow) and walking paths from one to another. Public domain Wiki
502   Commons.

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504   Fig. 2. Pink Subasio limestone used to construct the St. Francis basilica at Assisi. Public domain Wiki Commons

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507   Fig. 3. St. Francis Preaching to the Birds. Giotto. 1295-1300. Louvre. Public domain Wiki Commons

508

509 Fig. 4. Limestone grotto at the monastery at Greccio, site of the first Nativity scene organized by Francis on Christmas in 1223. The
510 limestone outcrop was the original altar before another was placed above it when the Pope visited. The 14th century frescoes depict
511 the original Nativity scene. Photo by Ann C. Pizzorusso.

512

513

514 Fig. 5. Nativity. Andrej Rublev. Note how the figures are one dimensional and the entire work lacks perspective. First half of 14th
515 century. Moscow, Tretjakov Gallery. Public domain Wiki Commons

516

517   Fig. 6. Nativity. Giotto, c. 1303-c.1306 Scrovegni (Arena) Chapel, Padua, Italy. Public domain Wiki Commons

518

519 Fig. 7. Greccio, view of the monastery, location of the first living Nativity scene organized by Francis in 1223. Greccio is located along
520 a thrust fault and the monastery is located on carbonate units of the Sabina Sequence (Meso-Cenozoic). The village of Greccio is
521 located on the western slope of the Rieti basin, characterized by at least three main NNE-SSW trending Neogene thrust units made
522 of Meso-Cenozoic pelagic (ranging from Platform to basin) limestones and marls (Umbria-March facies). See geologic map in
523 appendix. Photo by Ann C. Pizzorusso

524

525 Fig. 8. View from the monastery at Greccio looking out at the fluvio-lacustrine and fan deposits. Greccio sits in the area of a thrust
526 fault which separates the fluvio-lactustrine and fan deposits (Upper-Pleistocene- Holocene) from the carbonates (middle Pleistocene-
527 Holocene) upon which the monastery is constructed. Photo by Ann C. Pizzorusso

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530 Fig. 9. Giotto. Nativity. Lower Church, Assissi c. 1310 Public domain Wiki Commons

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Fig. 10. Giotto. Nativity scene. C. 1297-1300. St. Francis Upper Church Assisi. Note the change of locus from the outdoor manger to
an urban, interior, populated, public church. Public domain Wiki Commons

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Fig. 11. The Flight into Egypt. Giotto. 1304-1306. Scrovegni (Arena) Chapel, Padua, Italy. Public domain Wiki Commons

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538   Fig. 12. The Dream of Joachim, Giotto. 1304-06 Scrovegni (Arena) Chapel, Padua, Italy. Public domain Wiki Commons

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541   Fig. 13. The monastery at La Verna located on Mt. Penna composed of Miocene calcarenite. Public domani Wiki
542   Commons

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545 Fig. 14. St. Francis Receiving the Stigmata. Giotto. 1318. Bardi Chapel, Santa Croce Basilica, Florence, Italy. Public domain Wiki
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549 Fig. 15. St. Francis Gives His Mantle to a Poor Man. 1297-1299. Basilica of Saint Francisi, Assisi, Italy. Public domain Wiki Commons

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551

552   Fig. 16. The Legend of St. Francis: Miracle of the Spring 1297-1300 Upper Church, Assisi. Note the calcareous sinter terraces.
553   Public domain Wiki Commons

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556   Fig. 17. Calcareous sinter terraces. Public domain Wiki Commons

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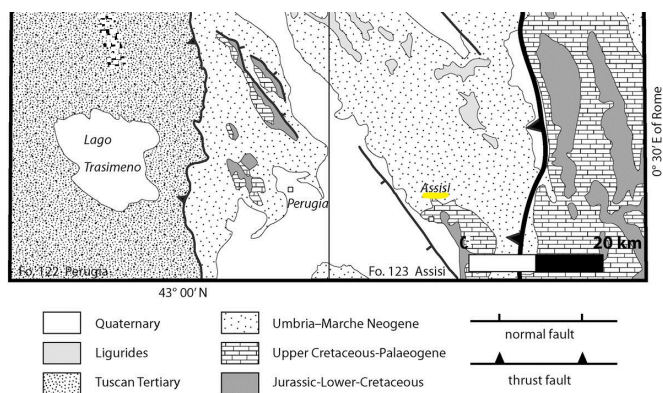


Fig. 18. Geologic map of the area around Assisi. Mt. Subasio is a massif of marine limestone (pink, cream, gray) which dominates the landscape around Assisi. The structural setting is complex and results from the superposition of two tectonic phases associated with the formation of the Apennines. The area is seismically active. The Basilica of St. Francis of Assisi was constructed with the indigenous pink Subasio limestone. After G. Lena, et al. Geological Society, London 409, November 2014.

563

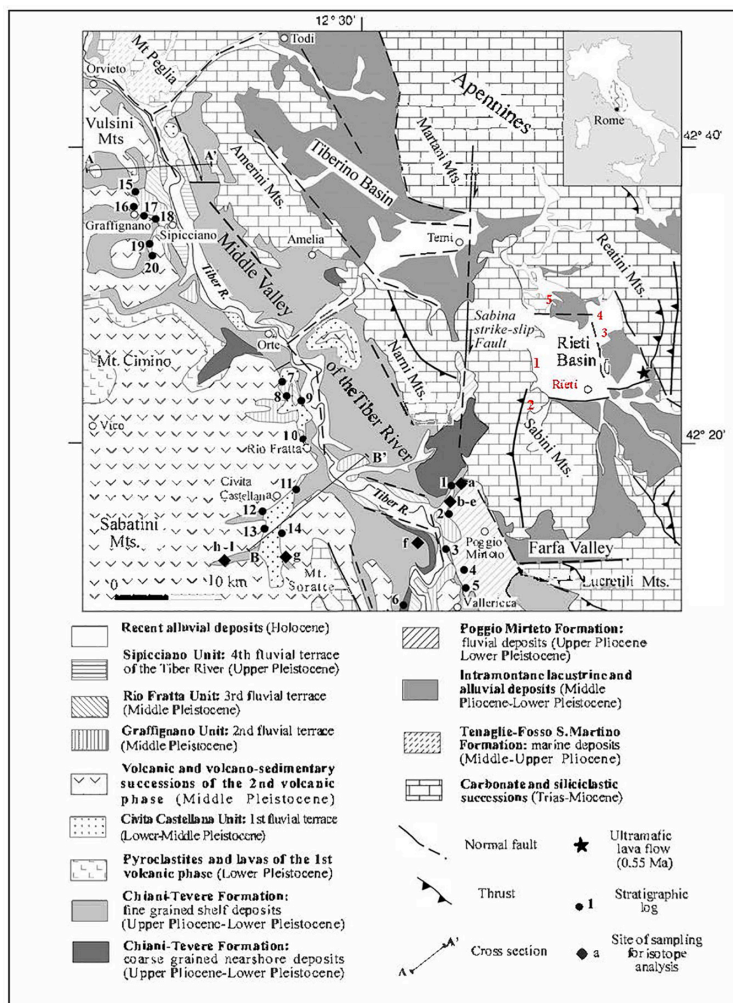
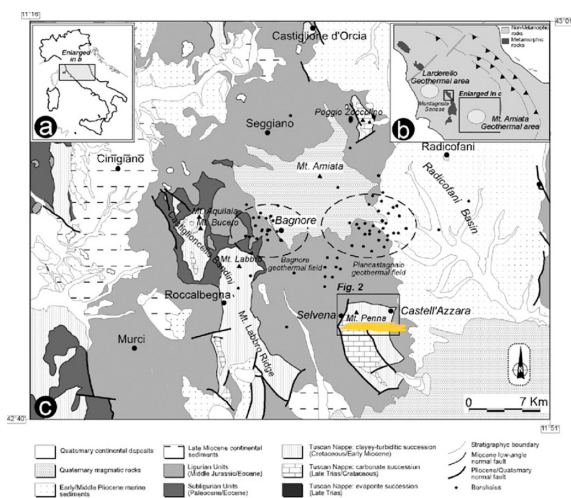



Fig. 19. Franciscan monasteries (in Red) 1) Greccio 2) Santuario di Fonte Colombo 3) Santuario della Foresta 4) Poggio Bustone 5) Labro. The Rieti basin is an intramontane depression of the Apennine chain. It is filled with continental plio-Quarternary sediments made of conglomerates, sands, silts and travertine deposits that reach a thickness of 400-500 meters. The origin and evolution of the Rieti basin is related to the post-collisional extensional tectonics that have strongly affected this section of the Apennine orogenic belt since the Pliocene. From the middle Pleistocene to Present along the course of the Velino river numerous travertine thresholds accreted controlled by alternating erosional and sedimentary phases. After Mancini, et. al. (2009). The Middle Valley of the Tiber River, Central Italy: Plio-Pleistocene Fluvial and Coastal Sedimentation, Extensional Tectonics and Volcanism.

573

574

575   Fig. 20. The monastery at La Verna sits on Mt. Penna, a Miocene calarenite. It is highly fractured and
576   many caverns and clefts are etched into its surface. Boulders and scree surround the base of the
577   mountain. It rests on Cretaceous successions belonging to the eastern Ligurian Units (Sillano Formation,
578   Early Cretaceous). After Brogi, A., et. al. Italian Journal of Geosciences 129(1) 74-90, February 2010.