**ID:** 40

# Evaluating pre- and syn-eruptive characteristics of distributed volcanic field eruptions: New insights into storage conditions, ascent rates, and eruption volumes

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Preparing for the next distributed volcanic field (DVF) eruption is challenging given uncertainties in eruption run-up, vent location, and eruption style and duration. We combine a review of global DVF data with new work in central Oregon, USA, to investigate characteristics of DVF eruptions, including pre-eruptive storage conditions and timescales, magma ascent rates, and typical eruption volumes and products.

We find similarities and common features of DVFs that may help us prepare for future eruptions. First, crystal zoning timescales show that pre-eruption intrusion and mixing events are common; many (~50%) occur within 10 days of eruption, and most (~80%) record mixing within ~3 months of eruption. Second, many DVFs have characteristic pre-eruptive storage depths, likely related to tectonic setting. For example, most magmas in the intraplate Auckland Volcanic Field (AVF, New Zealand) ascended directly from the mantle, whereas DVF magmas in continental subduction zones record pre-eruptive storage in the mid-upper crust (~2–8 km). Third, ascent rates for DVF magmas suggest similar, rapid, ascent timescales. Most (64%) estimated ascent rates are >1 m/s and 67% indicate magma rose to the surface in under 10 hours. Such rapid ascent, some from mantle depths, suggests we may have little warning between onset of ascent and eruption. Fourth, typical eruption volumes vary between DVFs; for example, the Michoacán-Guanajuato VF produces generally larger volume eruptions, with more variable proportions of explosive / effusive eruption products, than AVF eruptions. Altogether, our work highlights new advances, and outstanding issues, in our understanding of DVF activity.

**ID:** 118

**Spatio-temporal evolution of distributed volcanic fields, case studies: Sierra Chichinautzin and Michoacán-Guanajuato, México.**

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We identify spatial and temporal distribution patterns of past eruptions from the analysis of volcanoes in the volcanic fields of Michoacán-Guanajuato (MGVF) and Sierra Chichinautzin (SCVF) in central Mexico, allowing us to get some insights as to where an eruption might occur in the future and to helps us constrain volcanic hazards. The total number of vents in SCVF is 227 in an area of 3,500 $km^2$ and the average density of 0.064 volcanoes/$km^2$ for the whole field. In the MGVF there are 1,148 volcanoes in an area of 26,200 $km^2$, with an average density of 0.043 volcanoes/$km^2$ for the whole field. The MGVF is composed of four main clusters, so we defined it as the Michoacán-Guanajuato Supercluster (MGS). The individual clusters are Valle de Santiago Volcanic Field (VSVF), Uruapan Volcanic Field (URVF), Apatzingán Volcanic Field (AGVF) and Pátzcuaro Volcanic Field (PCVF). A cluster agglomerative hierarchical method and kernel analysis confirm that. Using an earthquake catalog from 1973 to date we processed 9,016 earthquakes in MGVF and 841 in SCVF. The spatial distribution of the hypocenters does not express any trend that could be associated with any superficial movement of magma in the SCVF. However, in MGS, eight seismic swarms since 1997 were detected. These swarms are interpreted to result from ascending magma. We conclude that future eruptions could be located in areas of higher vent density. It is urgent to strengthen monitoring systems and reinforce mitigation measures to deal with future volcanic hazards and risk.

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**ID:** 144

**El enigmático volcán Acatlán: vulcanismo complejo de pequeño volumen en el Campo Volcánico de Xalapa, México**

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El Campo volcánico de Xalapa (CVX) consiste de 72 volcanes de pequeño volumen agrupados en 7 clústeres localizados al oriente de la Faja Volcánica Trans-Mexicana, arco volcánico continental del Mioceno al presente. El volcán Acatlán se localiza al norte del CVX en el clúster de Naolinco, donde se ubica la ciudad homónima. Trabajos previos estimaron edades de 1.2 Ma para lavas debajo del Acatlán. En este trabajo se realizó mapeo y descripciones litoestratigráficas de depósitos piroclásticos y lavas, fechamientos por radiocarbono, análisis químicos y mineralógicos para determinar edad, composición y mecanismos eruptivos asociados al Acatlán. El Acatlán es un volcán basáltico-andesítico (52-54 wt. % $SiO_2$) de morfología e historia eruptiva compleja, ya que consiste de un cono de tobas coronado por un cono de escorias, flujos de lava emplazados hacia el sur y secuencias piroclásticas distribuidas al norte. La pared sur del cono de tobas está colapsada y delimita la separación con la cima de escorias. Los depósitos piroclásticos comprenden 15-20 m-espesor de oleadas húmedas principalmente, seguidas de 10 m-espesor de oleadas secas y caídas de ceniza y escoria. Estas características sugieren la transición de hidromagmatismo a magmatismo y el agotamiento del suministro de agua al final del evento. En la actualidad, las lavas impermeables debajo del Acatlán mantienen cuerpos de agua y escurrimientos someros en la zona. Aquí proponemos que esta fuente de agua, sumada a posibles condiciones meteorológicas extremas, interactuaron con el magma durante la erupción del Acatlán, modificando el paleo-relieve.

**ID:** 198

# The magmatic system of Taal Volcano, Philippines: Insights from pre- and post-eruption integrated temporal monitoring

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Taal Volcano, the Philippines' deadliest active volcano, produced an explosive eruption (VEI 3) in January 2020. Its post-2020 behavior has been characterized by seismic swarms, short-lived phreatomagmatic eruptions and intense degassing, defining a longer period of unrest. We enhance our understanding by integrating time-lapse gravity measurements with high-resolution multi-parameter monitoring data, including ground deformation, seismicity, $SO_2$ flux, and hydrologic data.

In November 2018, a significant increase in temporal gravity (~150 µGal), was observed in the northern sector of Taal Volcano Island (TVI). This change foreshadowed a seismic swarm (50 volcanic earthquakes) on March 22, 2019, and slight inflation of the edifice beginning January 2019. This precursory gravity change may be explained by increased mass from shallow magmatic intrusions and/or changes in the associated hydrothermal system. Thirty-two stations were present on TVI prior to January 2020 but were destroyed during the eruption. The network was expanded to 58 stations covering Taal Caldera and TVI, enabling quarterly gravity measurements to present. From June to November 2020, there was a gravity decrease (-180 µGal) in the TVI northern sector, accompanied by continuous decline in seismicity, deflation, and low $SO_2$ flux. Subsequent activity including phreatic bursts and intense degassing, was bracketed by significant precursory and posterior gravity change (~100-200 µGal increase, ~150-230 µGal decrease).

This study highlights the importance of integrated multi-parameter temporal analyses for a greater understanding of volcanic systems, particularly detection of precursory signals in support of future early warning systems.

**ID:** 200

**Favorable environments for water-magma interaction: Phreatomagmatic volcanoes in the Trans-Mexican Volcanic Belt**

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The formation of phreatomagmatic volcanoes (PV) usually involves small volumes of magma but also violent eruptive activities. Often, human settlements are built around or inside PVs. However, their shapes and relatively small size can be misguiding regarding the hazard that this type of volcanism represents, especially in the absence of knowledge about the conditions that result in this type of eruptions. Along the Trans-Mexican Volcanic Belt (TMVB) the basic conditions that favor water-magma interaction are provided by the predominant small-volume monogenetic volcanism and several inter-montane lacustrine basins. The TMVB is dominated by >3000 monogenetic volcanic structures with only ~3% being the result of phreatomagmatic eruptions, moreover ~70% of them are clustered in three specific areas within volcanic fields in Valle de Santiago, Serdán-Oriental, and Los Tuxtlas. Given the conditions, such a low frequency of PV and their selective locations leads to the hypothesis that local environmental conditions play an important role in their formation. An inventory of 103 PVs within the TMVB has been compiled, including tuff cones, tuff rings, and maar-diatremes. The inventory contains morphometric parameters for each structure along with data regarding geological (internal) and environmental (external) parameters of the areas where the PVs are built. In the TMVB the formation of PVs seems to be related to different combinations of environmental parameters whose influence varies spatially and temporally. A couple of parameter sets are met more often, reflected in the clustered PV areas, but less frequent sets of parameters are also detected, reflected in the scattered PVs.

**ID:** 532

## How do monogenetic and poligenetic volcanoes interact near México City?, ¿Cómo interactúan los volcanes monogenéticos y poligenéticos cerca de la Ciudad de México?

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El volcán Popocatépetl ha estado en erupción dese 1994. Las fluctuantes pero frecuentes emisiones han producido caída de ceniza en un radio de más de 100km que incluye la Ciudad de México, Puebla y otras grandes ciudades y pueblos. Durante este periodo hemos muestreado las principales emisiones inmediatamente y realizado estudios petrográficos, geoquímicos y texturales detallados. Las dacitas y andesitas calcialcalinas están relacionadas a varias fuentes y profundidades. Los volcanes monogenéticos cercanos, que afectaron a la población pre-Colombina también fueron estudiados. Dominan las andesitas calcialcalinas pero algunas son transicionales a basaltos alcalinos y dacitas. Los magmas de algunos conos altos en Mg podrían ser parentales a algunos de los dos. Las dos áreas presentan la misma tectónica regional.

Popocatépetl volcano has been erupting since 1994. Fluctuating but frequent emissions have produced ash-fall over more than a 100km radius that includes Mexico City, Puebla and other major cities as well as small towns. During this eruptive period we have sampled the main emissions immediately after and carried out detailed petrographic, geochemical and textural studies. Calk-alkaline dacitic to andesitic ejecta are related to several different sources and depths. Young monogenetic volcanoes nearby, that impacted the pre-Colombian population were also studied. Calc-alkaline andesites dominate but some are transitional to alkaline basalts and dacites. Magma fron higher Mg cones could be parental to some of both. Both áreas share the same regional tectonics.

**ID:** 581

## Monogenetic volcanism in the Valle de Santiago area, NE sector of the Michoacán-Guanajuato Volcanic Field, Mexico

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The Valle de Santiago (VS) area lies in the NE sector of the Michoacán-Guanajuato Volcanic Field, within the central sector of the Trans-Mexican Volcanic Belt (TMVB). Geological mapping, $^{40}Ar/^{39}Ar$ and radiocarbon dating, morphometry, and whole-rock chemical and petrographic analyses provide insights into the stratigraphy and eruptive history of the VS area. A total of 118 volcanic landforms was identified, including 61 scoria cones/ramparts, 21 phreatomagmatic craters, 20 medium-sized shield volcanoes, 8 lava domes, and 8 lava flows. Volcanism in the VS area began ~8 Ma ago and after a long hiatus (~3 Ma), it resumed in the Pliocene at ~4.9 Ma, culminating in the Late Pleistocene (~11 ka). Up to the Middle Pleistocene, volcanism was predominantly effusive, forming voluminous medium-sized shield volcanoes. In the Late Pleistocene, volcanism persisted mainly along an NNW-SSE oriented stripe where phreatomagmatic activity dominated, facilitated by fractured aquifers on the slopes of shield volcanoes and water-saturated conditions due to humid climatic conditions. Juvenile products are mainly basaltic andesites/basaltic trachyandesites (52 vol.%), followed by andesites (32.9 vol.%), basalts/trachybasalts (13.8 vol.%), trachyandesites (0.9 vol.%) and rhyolites (0.4 vol.%). Notably, the chemical affinity of the volcanic products shifted over time, transitioning from solely sub-alkaline to both, subalkaline and alkaline by the Late Pleistocene. The VS area holds one of the three largest phreatomagmatic clusters in the TMVB and provides a record of intense volcanic activity during the Plio-Pleistocene.

**ID:** 123

**Historia eruptiva de los conos de escoria de La Joya, Campo Volcánico de Xalapa, México**

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El Campo Volcánico de Xalapa (CVX) consiste de 72 volcanes de pequeño volumen agrupados en 7 clústeres localizados al oriente de la Faja Volcánica Trans-Mexicana, arco volcánico continental del Mioceno al presente. El clúster La Joya comprende 6 conos de escoria (Joya 1-6), 18 volcanes en total, en un área de 50-$km^2$ alrededor del poblado homónimo, 16-km al NO de la ciudad de Xalapa, una de las zonas más densamente pobladas al este de México. El clúster incluye al cono compuesto más joven del CVX – El Volcancillo de 780 BP. Se conocen edades de Joya 1 y 6 de 40-mil BP y la distribución de algunos flujos de lava asociados. En este trabajo se determinaron las relaciones estratigráficas a detalle entre los 6 conos de escoria, flujos de lava y diques, y se estimaron mineralogía, composición química y nuevas edades por radiocarbono. Conos, lavas y diques varían entre basaltos de olivino y andesitas-basálticas de plagioclasa y piroxeno (49-53 wt.% SiO2). Estos magmas hicieron erupción de manera continua hasta 40-mil BP a través de diferentes bocas eruptivas, formando conos de volúmenes de 17-60-mil $km^3$ y al menos un escudo de lavas que modificaron la paleotopografía en un corto periodo de tiempo, alcanzando el actual límite NO de Xalapa. Conos y lavas fueron después parcialmente cubiertos por lavas basálticas microcristalinas de Volcancillo. De ocurrir hoy un escenario eruptivo como este en el clúster de La Joya u otro del CVX, sería devastador para aproximadamente 70-mil habitantes de La Joya-Xalapa y zona conurbada.

**ID:** 414

**Similarities and differences of the distributed volcanism in Los Andes Central Volcanic Zone and the Trans Mexican Volcanic Belt**

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The Andes Central Volcanic Zone (CVZ) extends ~1,500 km through southern parts of Peru, Chile, Bolivia, and Argentina, constituting the Cordillera and Altiplano-Puna provinces parallel to the Atacama Trench. The volcanic activity of the CVZ has been continuous from the Upper Oligocene (<28 Ma) to the present. The CVZ is composed of ~60 potentially active stratovolcanoes intercalated by monogenetic fields. Just in the Chilean portion of the CVZ (46,610 km$^2$), 906 Neogene-Quaternary monogenetic volcanoes can be found, distributed on five main groups, most of them (363) emplaced during the Pleistocene and 18 in the Holocene. 306 centers correspond to parasitic monogenetic volcanoes associated with polygenetic volcanoes, and 601 centers to individual monogenetic volcanoes. The density of monogenetic volcanoes in the CVZ is 0.019 volcanoes/km$^2$.

The Transmexican Volcanic Belt (TMVB) extends approximately 1,000 kilometers east to west, from the Gulf of Mexico to the Pacific Ocean, oblique from the Mesoamerican Trench in Central México, comprising an area ~160,000 km$^2$. Volcanic activity in the TMVB began in the mid-Miocene (<20 Ma) and expanded to the present. Nearly 2,500 monogenetic eruptions have been recognized in the TMVB, grouped into eight groups in which between 50 and 1,000 eruptions have occurred, with a density of 0.015 eruptions/km$^2$.

The monogenetic structures that commonly occur in both volcanic regions consist of maars, isolated lava flows, domes, and scoria cones. In this work, we present a comparison between both monogenetic regions to better understand both evolutionary patterns and better constrain associated risk.

**ID:** 535

# Transition from polygenetic to monogenetic volcanism in the southern Mexico Basin. Transición del vulcanismo poligenético al monogenético en el sur de la Cuenca de México

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In the southwestern part of the Basin of Mexico, where Mexico City was built, older large polygenetic domes complexes converge with smaller monogenetic domes of intermediate age and younger monogenetic cones from Chichinautzin Monogenetic Volcanic Field (CMVF). Volcanic and tectonic structures were mapped to define temporal and spatial characteristics as well as eruptive style. Petrographic and geochemical results indicate the existence of at least two magmatic sources. Transition from polygenetic to monogenetic volcanism was progressive over time, which was controlled by tectonics. Older polygenetic domes had larger magma volumes and were dacitic to andesitic. Small domes were dacites to andesitic-basalts, and younger monogenetic cones were andesites to andesitic-basalts. Popocatépetl, an active polygenetic volcano to the east also coexists with monogenetic cones of CMVF.

Al suroeste de la Cuenca de México, donde está la Ciudad de México, convergen grandes complejos de domos poligenéticos antiguos con domos monogenéticos más pequeños de edad intermedia y conos monogenéticos más jóvenes del Campo Volcánico Monogenético Chichinautzin (CVMC). Se mapearon estructuras tectónicas y volcánicas para definir características temporales y espaciales, y su estilo eruptivo. La petrografía y geoquímica indican la existencia de al menos dos fuentes magmáticas. La transición del vulcanismo poligenético al monogenético fue un cambio progresivo en el tiempo controlado por la tectónica. Los domos dacítico a andesítico, poligenéticos tienen mayores volúmenes. Los domos pequeños son dacitas a andesitas-basálticas y los conos monogenéticos de andesitas a andesitas-basálticas. Popocatépetl, un volcán poligenético activo al este también coexiste con conos monogenéticos del CVMC.

**ID:** 670

## "POLYCYCLIC" VOLCANOES: INFERENCES FROM FACIES ANALYSIS AND INTERNAL ARCHITECTURE OF EL CARRIZAL DIATREME, SALTA GROUP, CRETACEOUS-PALEOGENE RIFT IN NORTHWESTERN ARGENTINA

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Maar-diatreme volcanoes, the most abundant volcanic structures on Earth's surface after scoria cones, have traditionally been linked with short-duration eruptions, low volume, and simple, dispersed feeding systems. Recent research has unveiled the complexity of monogenetic volcanism, exemplified by polycyclic maar-diatreme volcanoes. These structures result from numerous overlapping eruptive events within a confined area and at different times. The Cretaceous-Paleogene rift in northwestern Argentina provides remarkable records of both effusive and explosive volcanic activity related to the Salta Group. This study aims to contribute to the understanding of maar-diatreme evolution through detailed identification and mapping of different facies. The research involved analyzing stratigraphic relationships, lithofacies contacts, and internal deposit structures. Several facies were distinguished, including bedded pyroclastic deposits with bomb impacts, and massive and poorly sorted pyroclastic deposits. Bedded pyroclastic deposits represent upper diatreme facies, whereas massive pyroclastic deposits indicate lower diatreme facies. Three units were defined using the Units Bounded by Unconformities (UBSU) concept, representing diatremes with different exposure levels. The study revealed a complex system comprising three coalesced diatremes formed by distinct phreatomagmatic pulses. These findings support the concept that monogenetic volcanoes can be polycyclic, forming intricate structures through multiple separate eruptive events over time. Therefore, investigating the evolution of these ancient volcanoes constitutes a crucial tool to expanding our knowledge of the hazards and risks associated with active monogenetic volcanic fields.

**ID:** 746

**Newly identified monogenetic volcanoes in Antioquia, Colombia: the possibly northernmost volcanic monogenetic volcanic field of Andes Cordillera.**

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Associated with the Combia Volcanic Complex (CVC) around Venecia and Fredonia villages in Antioquia, Colombia (NW of the country) there are some hills that have been described up to now as porphyritic hypabyssal bodies or simply named dome-like because of their morphology. Among them are Cerro Tusa, Cerro Bravo, Cerro El Sillón and some others, whose prominent topographies are a characteristic part of the region's landscape. These hills have characteristics that suggest that they may be volcanic emission centers, such as their dome or conic-like morphologies and their surrounding lava emplacements and deposits, which contain both porphyritic andesitic lavas and bead-crust blocks or bombs. Considering the cluster distribution and the volcanic characteristics of Cerro Tusa, Cerro El Sillón and Cerro Bravo, we have hypothesized that there is a monogenetic volcanic field. If so, this newly described monogenetic volcanic field would be the northernmost documented so far in Colombia and in turn in the Andes Mountains. This project seeks to carry out a petrographic, geochemical (XRF) and geochronological (K/Ar) characterization of samples collected around each of these possible volcanoes. The results will help us establish whether a monogenetic volcanic field developed southwest of the department of Antioquia, with activity subsequent to that of the CVC at that location. This would have implications in terms of the tectono-magmatic characteristics of the subduction to the north of the Andes and a better understanding about the origin of these iconic landscape features for surrounding communities.

**ID:** 775

**The geochemical evolution and hazard prediction of silicic peralkaline volcanoes**

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In most silicic volcanism, the eruptive onset is triggered by a combination of magmatically induced pressure and the volatile enrichment within the melt. However, peralkaline volcanism shows a particularly large diversity of eruptive initiation, styles and deposits, despite only subtle compositional differences. Alkaline elements such as potassium (K) and sodium (Na), along with trace-element volatiles such as fluorine (F) and chlorine (Cl), act as efficient network breakers, depolymerizing silicate chains and inducing magma viscosities up to three orders of magnitude lower than calc-alkaline equivalents. However, this reduced viscosity in silicic peralkaline system host various implications in their monitoring and eruptive mechanic, making conventional hazard predictions potentially problematic. Effective degassing allows gas to escape magmas more passively as magmas depressurise near the surface, resulting in extensive foams that can cause both explosive (sub-)Plinian eruptions, while also allowing basaltic eruptions from the degassed residual melt. In addition, the abnormally high alkaline content means significant concentrations of fluorine and chlorine is present within the system, causing substantial soil- and air contamination across a wide footprint far extending from the volcano. Using the only predominantly silicic peralkaline volcano within New Zealand, Tuhua volcano, this study seeks to understand its historic volcanic behaviour and broaden our understanding of silicic peralkaline volcano hazard management by studying the range and impact of its largest historic eruptions, and closely evaluating the evolution of its magmatic system over time.