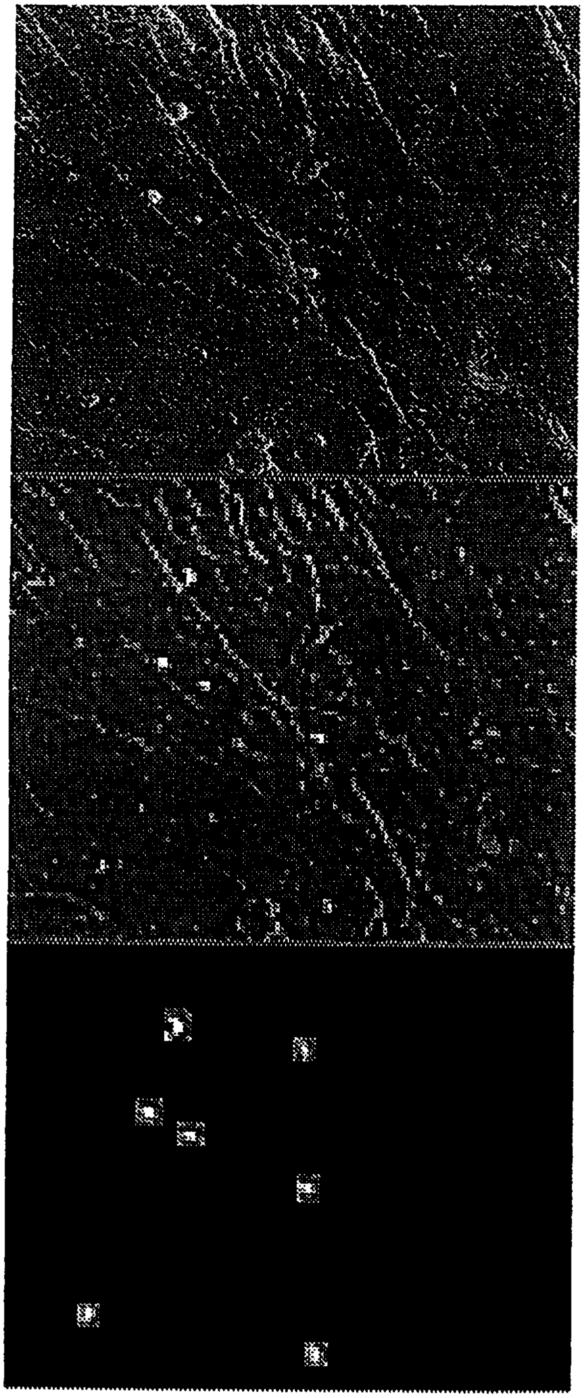

Fig. 1. Original Magellan SAR data (top), bandpass filtered version of same (center), and detected regions of interest (at 1/4 resolution) (bottom).

Ongoing Work: We anticipate that a much higher classification accuracy can be achieved by incorporating prior knowledge about the imaging and geologic processes, i.e., noise properties, surface radar reflectivity, expected volcano diameters, and so forth. By treating the output activations of the network as estimates of posterior class probabilities, both data-driven evidence and prior knowledge can be integrated directly in terms of a coherent probability model such as a Bayesian network, which incorporates appropriate conditional independence assumptions. Note that if the posterior probabilities at a given level are not confident enough (not close to 0 or 1), the Laplacian hierarchy can be descended for a higher-resolution analysis. Another significant issue is the incorporation of global context models (spatial correlation of geologic features) with local evidence. In the context of currently available image analysis algorithms and tools, these issues somewhat push the state-of-the-art.

Conclusions: In terms of pattern recognition, even though 100% accuracy will not be achievable due to the inherent ambiguity in the image data, the general method has significant practical benefit as a basic tool for aiding rapid scientific exploration of the large Magellan database. A short-term scientific benefit will be to answer the basic question regarding the approximate number and distribution of these volcanos on the surface of Venus. Long-term scientific benefits would include subsequent spatial cluster analysis of the volcano locations and the association of the volcanos with local structural patterns. It is reasonable to suggest that the application of pattern recognition techniques will enable basic scientific research that otherwise would not be possible by manual methods.

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MELTING AND DIFFERENTIATION IN VENUS WITH A "COLD" START: A MECHANISM OF THE THIN CRUST FORMATION. Viatcheslav S. Solomatov and David J. Stevenson, Division of Geological and Planetary Sciences, 170–25, California Institute of Technology, Pasadena CA 91125, USA.

Recent works [1–3] argue that the venusian crust is thin: less than 10–30 km. However, any convective model of Venus unavoidably predicts melting and a fast growth of the basaltic crust up to its maximum thickness about 70 km limited by the gabbro-eclogite phase transition [4]. The crust is highly buoyant due to both its composition and temperature and it is problematic to find a mechanism providing its effective recycling and thinning in the absence of plate tectonics. There are different ways to solve this contradiction [5,6]. This study suggests that a thin crust can be produced during the entire evolution of Venus if Venus avoided giant impacts [7].

The absence of giant impacts means that Venus' interiors were more cold and more water-rich than the Earth's after the accretion and core formation. The initial temperature distribution after the core formation is not necessarily convectively unstable: The viscosity is extremely sensitive to the temperature and uncertainties in the initial thermal state easily cover the transition from conductive to convective regimes. Convection and conduction-convection transition are parameterized for the temperature-, pressure- and stressdependent viscosity with the help of a recently developed approach [8] and the thermal evolution of Venus with melting and differentiation is calculated.

The model predicts that only a small amount of melt is extracted in the first period of evolution; however, this would result in a strong depletion in radioactive elements and devolatilization of a part of the upper mantle. Independently of the thickness of this differentiated layer, only about a 300-km layer contributes to the crust formation (a depth below which the melt is supposed to be denser than the surrounding rocks). A small buoyancy of this depleted layer is sufficient to stabilize this layer with respect to the undifferentiated mantle. This prevents supply of the undifferentiated material to the melting region. Convection occurs eventually in both layers. The lower, undifferentiated layer is heated from within. The upper, differentiated layer is mainly heated from below. The temperature increases and reaches the anhydrous solidus only after several billion years depending on the rheological model. The young basaltic crust observed on Venus is produced by melting of the anhydrous layer. This melting and the crust growth are weak mainly because of the lower heat flux consisting of the radiogenic heat production in the undifferentiated lower layer and almost not contributed from the secular-cooling heat flux from the core (it is even negative) and the remaining radioactivity in the differentiated layer. An additional consequence of the model is that the magnetic field was never generated in venusian history.

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THE TECTONICS OF VENUS: AN OVERVIEW.

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Introduction: While the Pioneer Venus altimeter, Earth-based radar observatories, and the Venera 15–16 orbital imaging radars provided views of large-scale tectonic features on Venus at ever-increasing resolution [1–3], the radar images from Magellan constitute an improvement in resolution of at least an order of magnitude over the best previously available [4]. A summary of early Magellan observations of tectonic features on Venus has been published [5], but data available at that time were restricted to the first month of mapping and represented only about 15% of the surface of the planet. Magellan images and altimetry are now available for more than 95% of the Venus surface. Thus a more global perspective may be taken on the styles and distribution of lithospheric deformation on Venus and their implications for the tectonic history of the planet [6].

Generalizations: Tectonic features on Venus are widespread and diverse, and comparatively few regions are undeformed. Areas lacking tectonic features at Magellan resolution are restricted to relatively young volcanic deposits and the younger impact craters and associated ejecta. Most of the surface, during at least some period over approximately the last 500 m.y. [7,8] has experienced horizontal strain sufficient to fault or fold near-surface material.

Tectonic activity on Venus has continued until geologically recent time, and most likely the planet is tectonically active at present. Several arguments support this inference. The great relief and steep slopes of the mountains and plateau scarps of Ishtar Terra and of the equatorial chasm systems are difficult to reconcile with long-term passive support by crustal strength. Because of the high surface temperature on Venus, temperatures at which crustal rocks fail by ductile flow should be reached at much shallower depths than on Earth [9,10]. Numerical models suggest that areas of high relief and steep slope in the Ishtar region should spread under self-gravity by ductile flow of the weak lower crust on time scales less than about 10 m.y. [11]. Thus the processes that build relief and steepen slopes must have been active within the last 10 m.y. Further, a number of features produced by geological processes that have operated more or less steadily during the past 500 m.y. show evidence of subsequent tectonic activity. About one-third of all preserved impact craters on Venus have thoroughgoing faults and fractures, and 1 in 12 are extensively deformed [8]. The longest lava channel on the plains of Venus does not progress monotonically to lower elevations downstream, indicating that differential vertical motions have occurred since the channel was formed [12].

Compared with the Earth, horizontal displacements on Venus over the last 500 m.y. have been limited. Most of the tectonic features require modest strains and horizontal displacements of no more than a few tens to perhaps a few hundreds of kilometers. Plains thousands of kilometers across record horizontal strains of order 10^{-2} or less. The great rift systems of Beta and Atla Regiones need have extended no more than a few tens of kilometers, on the basis of topographic profiles, extended features such as Somerville Crater in Devana Chasma, and analogy with continental rifts on Earth [13]. For compressional features, the amount of crustal thickening can be estimated from topographic relief and isostatic considerations, but this approach provides only a lower bound on horizontal displacements if any crustal material is recycled into the mantle at zones of underthrusting. For ridge belts 100 km in width with up to 1 km of relief, horizontal displacements of no more than 100 km are required for crustal thicknesses of 10–20 km beneath the adjacent plains [14,15]. Mountain belts are exceptional in that greater horizontal displacements are required. For a two- to four-fold thickening of the crust beneath the 500-km width of Maxwell Montes, the implied minimum horizontal displacement is 1000–2000 km.

Unlike the Earth, Venus does not show evidence for a global system of nearly rigid plates with horizontal dimensions of 10^3–10^4 km separated by narrow plate boundary zones a few kilometers to tens of kilometers across. Predictions prior to Magellan that Aphrodite Terra would show features analogous to terrestrial spreading centers and oceanic fracture zones [16] now seem to be incorrect. Evidence for shear is present in the ridge and fracture belts and in the mountain belts, but the shearing tends to be broadly distributed and to accompany horizontal stretching or shortening. Few clear examples have yet been documented of long, large-offset strike-slip faults such as those typical of oceanic and many continental areas on Earth; two such features have been identified in the interior of Artemis Corona [17]. A number of the chasm systems of Venus have arcuate planforms, asymmetric topographic profiles, and high relief [18] and have been likened to deep-sea trenches on Earth [17]. These include Dali and Diana Chasmata [17] and the moat structure of Artemis Corona; such trenches may be the products of limited underthrusting or subduction of lithosphere surrounding large coronae [19]. Elsewhere, however, chasm systems of somewhat lesser relief display more linear segments and