This $3C$ type was obtained for specimens between $Fe_{0.91}S$ and $Fe_{0.89}S$ quenched from 300°C, and between $Fe_{0.93}S$ and $Fe_{0.90}S$ quenched from 250°C. Crystals of this type ($Fe_{0.90}S$) were examined at high temperatures with the Nonius-Weissenberg camera; oscillation photographs taken at 290°C around the c-axis, after heating at the same temperature for 2 hours, gave the $3C$-type patterns described. The superstructure reflections, however, disappeared at 320°C, leaving only "a"-type reflections. The superstructure reflections reappeared at 290°C and at room temperature soon after the heating; thus the $3C$ type is not a metastable quenched product, but a phase with a range of stability from below the transition temperature to the high-temperature phase at about 310°C. This finding confirms the transition (*4*) at about 315°C of pyrrhotite $\sim Fe_{0.90}S$ to the high-temperature NiAs type, and indicates that the $7C$ type (*2*) is a phase produced by quenching.

Now we describe the nonintegral type. The typical precession photograph $(010)_0{}^*$ with the $h0l$ reflections (Fig. 3) was taken from a crystal, of composition $Fe_{0.96}S$, quenched from 250°C. Only two groups of reflections are observed: the "a"-type reflections have the same indices here as in the $3C$ type; the "b"-type reflections are not observed; the "c"-type reflections, observed in pairs along the a^* direction in the $3C$ type, are here isolated and diffuse along the c^* direction. The reciprocal-space coordinates defining the positions of the intensity maxima of the "c"-type reflections were obtained from the specimens quenched from 250°C, because the "c"-type reflections are extremely diffuse for the specimens quenched from 300°C; they are

$$(h + \frac{1}{2}, k, l \pm \delta l)$$

$$(h, k + \frac{1}{2}, l \pm \delta l)$$

$$(h + \frac{1}{2}, k + \frac{1}{2}, l \pm \delta l)$$

where δl is positive and nonintegral. The value of δl varies continuously from $1/3$ to $1/7$ with chemical composition. Because the specimens of this type are conventionaly expressed by the values of the apparent c-length (NC, where $N = 1/\delta l$ is generally nonintegral), this type is called nonintegral. The relation between the value of N and chemical composition is illustrated for specimens quenched from 250°C (Fig. 4). The nonintegral type for the special case $N = 3$ differs from the $3C$ type, although both crystals have the same $c = 3C$. The "c"-type reflections are sharp and appear in pairs giving $a = 90A$ in the $3C$ crystals, while they appear as single reflections with diffuseness along c^* and give $a = 2A$ in the nonintegral type of crystals.

The nonintegral type was observed for specimens between $Fe_{0.97}S$ and $Fe_{0.92}S$ quenched from 300°C, and between $Fe_{0.97}S$ and $Fe_{0.94}S$ quenched from 250°C (Fig. 4). For investigation of their stability range, crystals of the nonintegral type were examined at high temperatures by the precession method. The "c"-type reflections from crystals $Fe_{0.95}S$ were very diffuse at 100°C and completely disappeared at 150°C, while those from crystals $Fe_{0.94}S$ completely disappeared at 200°C. Thus the transition temperature of the nonintegral type to the NiAs type depends on chemical composition.

The conspicuous variations, of the intensity maxima of the "c"-type reflections with composition, in pyrrhotites of the nonintegral type are quite similar to those of the "e"- and "f"-type reflections observed in plagioclase feldspars (*5*). Pyrrhotite is the first example of sulfides, as far as we know, in which superstructure reflections of the nonintegral type are confirmed; such reflections were also observed in the Cu-S system (*6*) and seem to be common in synthetic sulfides with solid-solution ranges. All natural pyrrhotites so far described have superstructures of the $2C$, $4C$, and $5C$ types, in which the cells are multiples of the NiAs type of subcell. These superstructures can be called integral types in contradistinction from the nonintegral type. Pyrrhotites of the nonintegral type are stable below the transition to the high-temperature form, but are considered to change to the low-temperature forms with superstructures of integral types.

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Bends: Detection of Circulating Gas Emboli with External Sensor

Abstract. *Circulating gas emboli associated with rapid decompression are detectable in superficial vessels of animals by the use of an ultrasonic Doppler flowmeter transducer which is applied externally.*

Gas embolism of capillary beds resulting from rapid decompression is believed to be largely responsible for the symptom complex commonly referred to as "the bends" (*1*). We demonstrated (*2*) that a surgically implanted Doppler ultrasonic blood flowmeter (*3*) can detect circulating gas emboli in the caudal vena cava of swine well before the first decompression stop recommended for man (*4*). We now describe an atraumatic, nonsurgical method for transcutaneous detection of circulating gas emboli in superficial vessels; our experience with three animal species suggests that the technique may have direct application to the prevention and treatment of the bends in human divers.

The Doppler flowmeter (*3*) measures velocity of blood flow by detecting the frequency shift incurred by ultrasound that is scattered from moving blood cells which produce audio signals whose amplitude depends on the scattering efficiency of the cells. Since gas bubbles are highly efficient scatterers, a gas embolus passing through the ultrasonic field produces a marked transient increase in the audio signal amplitude, with a characteristic sound best described as a "chirp." These artifacts are easily heard and may be discriminated electronically (*2*). Although the flowmeter was originally designed for chronic implantation by use of a perivascular transducer, it has since been modified for transcutaneous detection of flow in peripheral vessels (*5*). The first trials, in which air emboli were injected into animals, indicated that this technique was as sensitive to the presence of emboli as the perivascular technique was.

To provide variation in skin characteristics and circulation, three animal species—the dog, swine, and goat—were selected for air-decompression experiments. In each case, a transcutaneous flow transducer was taped to the skin overlying the chosen superficial vessel, and the anesthetized animal was placed in the hyperbaric chamber. Flowmeter output was telemetered (*6*) to a receiver outside the chamber and was recorded on magnetic tape throughout each run.

The dog (2 years, female beagle, 10 kg) was linearly decompressed over a 10-minute period after a 1-hour exposure to 5.3 atm (gauge reading; 53 m equivalent depth of sea water). A transducer over the right saphenous vein detected the first embolus at 4.3 atm (43 m) with several more occurring at 3.3 atm (33 m), both well before the first "stop" recommended for man by U.S. Navy tables (15 m) (*4*). Immediately after 0 atm was reached, the transducer was relocated over the right cephalic vein where embolic artifacts were so loud and numerous that the blood-flow background noise was obliterated. The swine (1 year, castrated male miniature, 48 kg) was linearly decompressed over a 12-minute period after a 30-minute exposure to 5.3 atm (53 m); emboli were detected in the left superficial epigastric vein at 0.6 atm (6 m) and became more numerous as decompression continued. The goat (2 years, male pygmy, 28 kg) was linearly decompressed over a 7-minute period after a 40-minute exposure to the same pressure. During decompression the animal struggled, displacing the transducer so that the time of the first embolic event could not be recorded; however, immediately after arrival at 0 atm, the jugular and saphenous veins contained emboli which produced embolic signals of great number and magnitude, nearly obliterating the background noise of blood flow.

These experiments establish that circulating gas emboli associated with decompression are detectable in major veins with the transcutaneous Doppler flowmeter. Although surgically implanted perivascular transducers will continue to be useful in applied research on animals, transcutaneous application is possibly of greater practical importance to man, on whom this technique has been applied in other studies (*7*). In particular, it has been long suspected that gas emboli form and circulate in the venous system, during marginal decompression procedures, before the onset of symptoms; some believe these "silent bubbles" may even occur during procedures which are now considered safe.

With no method to detect these emboli (if they exist) in man, decompression tables are now based on empirical procedures in which the announced discomfort of the subject is the indicator. Such methods are time-consuming and fraught with subjective error, and must be considered hazardous. If "silent bubbles" exist, and if the transcutaneous Doppler flowmeter can detect them before onset of symptoms, the situation could be improved greatly. Furthermore, there is no method available to correlate severity of symptoms with the degree of embolism or to assess the embolic status of unconscious patients undergoing therapeutic decompression. Current efforts to attain greater depths and longer exposure periods by the use of new gas mixtures can be expected to increase the hazards beyond those now endured, and may create an even greater need for objective methods of monitoring subjects. Based on our animal trials, it is evident that the transcutaneous Doppler technique warrants further evaluation.

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Cytoplasmic Activity in Type I Pulmonary Epithelial Cells Induced by Macroaggregated Albumin

Abstract. *After the intravenous injection of radioalbumin macroaggregate, large numbers of cytoplasmic inclusion bodies were observed in the lung tissue of rats. The inclusions were located mainly in the cytoplasm of type I alveolar lining cells, appeared 40 minutes after the injection, and lasted up to 2 days. These observations suggest that the type I alveolar lining cells participate in the clearing mechanism of the lung tissue, a function that thus far has not been attributed to this type of cell.*

The alveolar surface of the lung is continuously lined by a single layer of two types of epithelial cells: the type I and type II cells. At least 90 percent of the alveolar surface is covered by type I cells (*1*) that have attenuated cytoplasmic processes containing few mitochondria and sparse endoplasmic reticulum. Type II cells, wedged between type I cells, are cuboidal and their cytoplasm is rich in mitochondria, endoplasmic reticulum, and also electron-dense lamellar inclusion bodies. While type II cells have been of constant interest to investigators concerned with lung tissue, especially to those studying alveolar surfactant, type I cells have thus far received little attention. Except for their being part of the "air-blood membrane," no specific metabolic activity has been suggested for these cells. This report provides, for the first time, evidence that type I alveolar lining cells are capable of participating in physiologic processes occurring in lung tissue which apparently require high cellular activity.

Macroaggregated albumin labeled with I^{131} (15 μc/kg; specific activity 2 to 300 μc/mg) (*2*), a pharmaceutical used in radioisotope scanning of human lungs for diagnostic evaluation of certain disease conditions (*3*), was injected into the tail vein of Sprague-Dawley rats. Rectolinear scintiscans were carried out immediately thereafter to verify that the radioisotope had arrived in the lung. The animals were then killed at intervals varying from immediately after the injection to 6 days later. The lung tissue was prepared for electron-microscopic examination by fixation in phosphate-buffered osmium tetroxide, embedding in Epon, and staining with uranyl acetate and